THE

MINING MAGAZINE:

DEVOTED TO

Mines, Mining Operations, Metallurgy, &c., &c.

EDITED BY

WILLIAM J. TENNEY,

VOLUME NINE.

FROM JULY TO DECEMBER, 1857.

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VOL. IX.—JULY, 1857.—No. I.

Art. I.—MINERAL RESOURCES OF SOUTH CAROLINA. From the First Annual Geological Report. By Oscar M. Lieber, State Geologist.

South Carolina is especially rich in metals; for with these nature has most liberally supplied her, so that all who feel interested in her welfare must anxiously desire the arrival of a time, when these resources shall no longer be permitted to lie dormant, and metals shall assume their proper position among the productions and exportations of the State. To expedite this it is necessary that those injurious speculations, which have so greatly retarded the prosperity of mining, should be avoided, and that in all mining operations competent men should be at the head. We have numerous instances of failures owing to injudicious and ignorant management in our own State, and unfortunately such cases always have a tendency to stamp mining operations generally as uncertain and hazardous, while in reality they should be enumerated among the most valuable and important of all industrial modes of investment. As long as mining is regarded as a fit subject for speculation, failures must occur. In all other cases a good interest on the capital is thought a sufficient compensation; why then is it considered necessary that mines should double or treble the investment every year? It cannot surprise us that unreasonable demands should often be disappointed.

The subjects of this chapter are very distinct from one another. The metals are treated first. The following is the succession adopted:

Gold, copper, lead, manganese, bismuth, iron; brown coal, clays, building stones, limestone.

Gold.—Gold is one of the very few metals which have hitherto been mined in our State, although the manner in which the mining operations were conducted was of the rudest manner, and calculated for any thing rather than permanent advantage. It was entirely confined to what the Germans appropriately term "Raubbau" (robbery mining) and open cuts, that remind us of railroad excavations, and the present ruinous state of the mines attests the havoc which such injurious policy could not but pro-

duce. At present few gold mines in our State are in operation. The Martin, Hale, and Brewer mines were the only ones I found not utterly abandoned in the four districts surveyed this year, and at those a few gleaners only were earning a scanty sustenance, chiefly by re-washing the old sands and gravels. No one at all acquainted with mining could have otherwise than anticipated this result; for it is impossible that a profession, requiring as much study and experience as that of mining engineering, can be embraced and practised on the same day. The instances, therefore, where mining, under these circumstances, has been lucrative, are exceedingly rare. There is moreover an unfortunate fascination about gold mining ("it is ready money every night," as an old gold miner said to me once), that its attraction assumes a great similarity with gambling, when it is conducted as is usually the case with us. A fortune may therefore be made at it quickly, but it is speedily lost again in seeking more. Nevertheless, gold mining, when properly conducted, may be exceedingly productive. We find instances at Gold Hill and the Huey mine, at the latter of which, the clear profit is from $18,000 to $20,000 a month.

It is exceedingly to be regretted that there is no possibility of obtaining any correct information of the productions of our gold mines since their commencement. The ownership has generally changed rapidly. The returns made to the proprietors by the little companies to whom they have been in the habit of renting small lots, are generally very inaccurate; and even these, imperfect as they are, there seems a great dislike with most to make public. The cause of this may lie in a fear of taxation, if the value were to become known, but more probably it originates in a mere fancy for secrecy. From the United States mint some report of the kind might be obtained, but, as much of the gold passed through different hands before coinage, its origin was often unknown to the one who delivered it over to the mint.

Gold occurs in various ways in our State. In the districts surveyed we may thus make the following distinctions:

1. *Silicious gold veins*, among which we must again make some divisions. We have first the quartzose veins, which terminate in copper and belong to the class which I have termed the Carolina group (see copper); secondly, those where the quartz is of a granular, saccharine nature, rarely containing copper, and characterized by other features to be discussed hereafter; thirdly, the hornstone lenticular veins.

2. *Auriferous beds of the slates.* These I have found in the talcose as well as the clay slates.

3. *Auriferous gravel deposits.*

Although the portion of the State as yet examined is but small, it is probable that it contains instances of almost all the different modes of occurrence of this metal, which will be found in the whole of our State; at least none others, of any importance, have

yet been noticed in the auriferous States of the South. A trace only of gold I found in the porphyry of the Ried mine, in North Carolina. In auriferous localities on the Pacific, and in other countries, the gold rarely occurs otherwise than in quartz veins or gravel deposits.

Among the silicious gold veins the first which demand our attention are *true quartz veins, whose gangue rock is of a lively crystalline character, usually of a slightly bluish cast. The veins abound in iron pyrites in the upper part, while copper pyrites appear in greater or less abundance at a lower level* (see copper). The veins at the Ried mine in North Carolina, as far as the quartz is concerned, exhibit some similarity with the veins of this class, but iron pyrites is not abundant, and copper has only been found as a trace. The gold, which has now almost entirely disappeared at that mine, seems to have been confined to the upper portions of the veins, and was remarkably coarse or massive.* Veins resembling these I have not met with in our State, nor do I know of the existence of others like them in North Carolina. The veins, to which I at present desire to call attention in our State, are perhaps the most common of all our gold veins, and exhibit features which are apparently uninfluenced by the character of the country rock, as will be seen by the different ones found at the various mines. In the districts hitherto surveyed, I have met with veins of this description in gneiss, mica slate, talcose slate and clay slate, while in North Carolina they are also found in dioritic slate. These peculiar veins are apparently most strongly developed in the two Carolinas, and hence, for the convenience of ready distinction, the term of "the Carolina group" has been proposed in contradistinction to the cupriferous veins of the valley between the Blue Ridge and Alleghanies, which might very properly be designated as the "Ducktown group." We shall have occasion to return to the subject when observing their importance as cupriferous veins.

The gold in these veins was originally present in the iron pyrites, though the lower level of the auriferous portion appears generally to descend below the upper level of the cupriferous part; to what depth, however, it is, in but few cases, as yet possible to determine. In the upper portions of the veins, that is to say in the gossan, we usually find the gold coarsest, a fact which can only be explained by that aggregation of the particles of the existence of which we have so many evidences with this metal in veins, deposits, and even in old auriferous sands, which have been once already washed or submitted to amalgamation and have subsequently been left exposed to the influences of atmospheric action

* It was at this mine that the piece weighing 28lbs. was found. A story is fully admitted in the neighborhood that another nugget weighing 80lbs. was discovered there also, but I am unable to vouch for its authenticity.

for years. I shall have occasion to return to this subject when speaking of auriferous deposits and shall therefore omit its discussion for the present.

In York, Lancaster, and Chesterfield, we find several instances of veins belonging to this class. Those in York are: Wylie's mine, Smith's mine, Wilson's mine, Mary mine, Sutton's mine; besides some others of less importance. Those in Lancaster are: the Hagin mine and the Potts' mine. In Chesterfield we have only the Brewer & Edgeworth mine, for Mr. River's veins have not yet acquired much importance.

The *Wylie mine* is situated close to Mr. T. G. Wylie's store (Hickory Grove P. O.) in York District. The country rock is a talco-micaceous slate. The strike is N. 47° E. The vein is split up into several small ones, which in the aggregate are ten feet wide. The miners did not descend to a depth where the vein consolidates properly, nor did they work through the whole mass, but confined their labors to the hanging wall and the first five feet of the width of the vein. The dip of the country, with which that of the vein corresponds, is S. 43° E. about 50°. The work which was performed here was exceedingly limited, extending only over a period of five or six months, during which short time even, it was irregular and carried on by three or four hands only. A rocker and a little drag mill were the only means of separating the gold. The latter is, however, said to have yielded ten to fifteen pennyweights a day. Some exceedingly fine specimens were obtained here. The quartz is more crystalline than in any other veins I have observed in this district, and well-developed crystals of quartz are very common. A melaphyre dike appears in the immediate vicinity. The labor performed here was so very unsystematic and imperfect that very little towards a full exploration of the mine has been effected.

The *Smith's mines* are situated about one mile and a half west of the former. Unfortunately the works are in such a terrible state of dilapidation, having been abandoned for a number of years, that the observations, which it was possible to make, were necessarily exceedingly limited. Although at present in a state in which it was almost impossible to decipher the character of the work, it was yet easy to see that it had been very ignorantly conducted; shafts to strike the vein having, for instance, been sunk on the foot wall. The vein appears to have been very wide. The character of the quartz was of a kind to create confidence in the probability of finding copper, and I was afterwards successful in discovering some pieces of the gangue in which occurred some particles of malachite, that may, however, have formed from copper pyrites after it was brought to the surface. The small quantity of this mineral found would indicate that the copper level had scarcely been grazed. A dike of a syenitic rock occurs at the mine and very probably had some connection with the metalliferous contents of the vein.

The *Wilson mine* is situated about seven miles north-east of Yorkville. The country rock of this mine is micaceous slate. On the west, however, we find a continuation of the porphyritic dike, which is seen on the southern extension of the vein at the Mary mine. The strike is N. 35 E., showing a curve in the vein between the Wilson and Mary mines, at the latter of which the strike is in a north-westerly direction. The vein may be traced with interruptions in a north-eastern course towards the Catawba for eight miles. It would be more proper, therefore, to say, that a long succession of veins occurs in this direction. The Wilson mine is characterized by a very remarkable abundance of iron pyrites. As the ore worked was almost entirely confined to the gossan—in which the gold, originally present in the pyrites, had collected in particles whose size rendered them easier of extraction—a vast amount of valuable ore has been left on the surface and awaits the more perfect treatment, to which future enterprise may lead. The extraction of the gold from these auriferous pyrites should be preceded by a thorough process of roasting, as it was introduced near Rutherfordton in North Carolina, by Mr. C. Ringel, and afterwards practised, with entire success, on old tailings at the Gold Hill mine and others in North Carolina. The sulphur is thus removed, and the gold exposed to the action of the mercury. As this process does not afford sufficient time for an aggregation of the particles of gold to take place, these are necessarily of a fine grain, and, consequently, the amalgamation should be conducted with care, and every endeavor used to avoid the washing away of the microscopic particles by too strong a current of water, and by seeking to be over-expeditious in the extraction.

The works at the Wilson mine have progressed to a depth of upwards of a hundred feet, the vein averaging seven feet in the deepest points attained, but varying from two to nine feet. It belongs to T. P. Black, Esq., and most of the work was done by him. They attained a depth of twenty feet below water-level, and it was chiefly owing to the water and the want of proper arrangement to keep it down, that the mine was abandoned. Unfortunately this mine is among those, where cessation of work for a number of years, the caving in of some shafts and the filling up of others by water, caused the investigations to be chiefly confined to the attle heaps.*

This is probably the mine at which Mr. Tuomey discovered a trace of copper, although he merely designates the locality where he found it, as being on the waters of Alison creek. I myself

* *Attle Heaps* (German, *Halde*) are piles of dead rock and ore, not considered of sufficient value to work, which are thrown up near the pits. They very generally afford some of the best means of studying the character of the veins.

found a couple of minute particles of copper pyrites, and have no doubt whatever, that at a greater depth this vein will yield copper in a remunerative quantity. It is now offered for sale, and we may hope, as soon as mining enterprises are honored with a little more confidence in our State, to see this mine among the number which will be again put into operation.

At the *Mary mine*, at present the property of Mr. J. Turner, but which will, in all probability, be soon taken in hand by a company organized for the proper exploration of its valuable contents, we find, on the southern extension of the Wilson mine vein, that the copper level shows itself at the present surface of the ground. At the Wilson mine they have scarcely touched the cupriferous level of the vein. For a full description of the Mary mine, I must refer to the article on copper.

Sutton's mine is situated in the north-eastern corner of York district, east of the Catawba river, and, on account of the country rock, the richness of the ore and various other points to be noticed in connection with it, presents peculiar features, which attach more than ordinary interest to it.

This mine, the property of Mr. Wm. M. Sutton, exhibits a vein in a gneissoid granitic country. The strike is N. 52° W. the dip N. 38° E. 45°. At one point the vein widens to such an extent that quite a considerable hill is formed by the bulky outcrop of quartz. Towards the east the vein separates, or, to speak more correctly, another vein enters the main vein. The quartz of the veins is finely crystalline; but, owing to the decomposition of a great abundance of iron pyrites, exceedingly cellular. Jasper occurs in isolated bodies in the vein, but is probably confined to the gossan. The iron pyrites, which is unusually massive, in connection with the quality of the quartz, renders the discovery of copper beneath more than probable, although the value of its discovery is, as elsewhere, considered far less important than that of gold. The latter metal is very abundant here, and has been found in considerable quantity in the gossany outcrop of the vein, and on the surface of the footwall, although, as yet, nothing beyond mere surface panning has been engaged in.

The main vein, although in a granitic country, is accompanied by talcose slate on its wallings. This slate is of a chloritic nature, and is that which, in North Carolina, is termed the *slate of the vein*. It can only be regarded as a flockan, which has been subjected to metamorphosing action. Its width is variable and at no point considerable.

To those who may propose to work this mine at a future day, it may be of importance to know that a fine water power exists on the premises, which might be advantageously applied to run the stamps, &c., as it is but a short distance from the vein.

The *Hagin mine* is situated close to Bell Air in Lancaster district. A section of the vein is given in Plate IV. fig. 7. In it A

is the talcose slate country; B, the quartzose vein itself; C, auriferous gossan; D, the slate of the vein with gangue-breccia. The vein is four feet wide at the top. A few feet lower down it decreases to three feet. At the lowest point attained, it commences to widen again, the funnel shape of the upper part being the result only of the lateral sliding of the vein walls, as this has already been explained in fig. 4, on plate I. A great abundance of iron pyrites is seen in the upper part of the vein at E, E.

A number of years ago this mine was worked for gold, but it has been long abandoned. It is to be hoped that it will soon be resumed as a copper mine.

The quartz of the vein is porous, owing to decomposed iron pyrites in the upper part of the vein. It is also less crystalline than the quartz of the Mary mine, and rather more resembles the quartz of the Morgan Dover mine in York, though its less saccharine nature and an evidently increasing chrystalline character have induced me to describe it among the first class of gold quartz veins.

The quantity of iron pyrites and the quality of the quartz led me, on a visit in the early part of this year, to expect that copper would be found. The evening was, however, too far spent to admit of a careful examination. Later in the year another visit effected more definite results, and a number of specimens of copper pyrites were really found. This copper pyrites is disseminated through the quartz, and shows therefore some similarity with the copper at Morgan Dover's. It is probable, however, that this is a deficiency which will decrease in depth, and that it is, therefore, owing only to the fact that the cupriferous part of the vein has not yet been sufficiently entered to arrive at more massive bodies of the ore. The same may perhaps also be the case with the Morgan Dover mine, although the dissimilarities between the veins of these two places is sufficient, for the present at least, to separate them and place their descriptions under different heads.

The vein of the Hagin mine strikes N. 28° W. The dip is very nearly vertical, but an inclination towards a dip in a northerly direction is perceptible at the lowest point exposed, so that it would be on that side that a shaft to strike the vein should be sunk. If not met with at the depth calculated, a level, driven towards the south, would meet it.

The mine is at present the property of Mrs. John T. Hagin.

The *Potts mine* is situated in Lancaster district, one mile north of the Izell, and therefore close to the North Carolina line. The vein, indeed, extends into that State.

The strike of the vein is east and west. Its width is only two feet, but as very little work has been done and no greater depth than about half-a-dozen feet attained, there is every reason to expect that it will widen a great deal within unimportant depths, especially as the quartz is of that fine, bluish, crystalline char-

acter, which, with us, appears to be one of the very best evidences of persistency in depth.

The gossan of the vein has been worked by panning, almost exclusively, to a very slight extent, by a man of the name of Wm. Paxton. The depth attained was, however, sufficient to discover both galena and copper pyrites in addition to the gold. This vein is, therefore, one of those not over-abundant veins of the Carolina group, which also contain lead (see copper). The quartz renders an increase in the useful metals, especially the copper, very certain.

This mine is on a piece of property belonging to the late Mr. William Potts.

The *Brewer and Edgeworth Gold and Copper Mine* is situated in Chesterfield district on the waters of Thompson's creek. On Plate IV. figure 4, a section of the mine is given. A is the new red sandstone, through which one of the leaders (b) passes. B is the clay slate, the main country rock of the mine, which, as the figure shows, has a very variable dip at this point, a dip which is also quite unconformable with that of the new red. C is a little branch which separates the land of Mr. Joel Brewer, sr., from that of R. L. Edgeworth, sr., on both of whose properties some of the veins are situated. The intimate connection of the various veins on the two places, makes it necessary that they should be described together, notwithstanding the difference in the proprietorship. The main vein is seen at "a" on Mr. Brewer's property, while "b, c, d, e," and "f" are leaders and droppers, "e" and "f" being the only ones which are found to any extent on Mr. Edgeworth's place. These are ramifications or droppers of the main vein, and, although they at one time afforded a sufficient quantity of gold to remunerate the labors of the miners, yielding about $10,000, they have been entirely worked out. Their finite character was already established by the peculiar nature of the little, or microscopic (to use an appellation of Fournet's) veins in the slate on the attle heaps, an instance of the importance of studying the veinlets in piles of refuse, a matter upon which Zimmermann, of Clausthal, laid so much stress. This proves also how correct the advice of Fournet is, to devote the utmost attention to the study of the lesser (microscopic) veins, as they afford a perfect insight into the character of the larger ones, while their minuteness furnishes the means for a more comprehensive investigation.

The droppers of "e" and "f" on Mr. Edgeworth's land continue westward on Mr. Brewer's property, having been thrown off in a southerly direction by a large melaphyre dike, which continues thence south-east along the edge of the granite until it strikes the tertiary formation, as is shown on the map. These veins have, therefore, shifted their position, to which is owing the fact of their appearance on the Edgeworth side of the stream.

The quartz of all these veins is very peculiar, and with regard to its stratiform character resembles that of the Rea and Pioneer mines in North Carolina. It contains a great abundance of pyrites, both iron and copper, the latter increasing in quantity with the depth attained. The malachite, which is seen so frequently in the specimens lying about the old pits, has formed from the copper pyrites after it was brought to the surface. The copper pyrites is auriferous. The greater amount of this mineral on Mr. Brewer's side, where the deepest point reached is at a lower level than the bottom of the shafts on Edgeworth's side, furnishes an additional proof, if any were needed, that the increase of copper is in a downward direction with the veins of this class.

The size of the veins, as far as we know them at present, is comparatively slight and does not exceed one foot. Should the working of the mine be resumed, it will require a skilful superintendence, as there will undoubtedly be many shifts and slides in the veins. From the section it will be apparent to every one, that Mr. Edgeworth's property presents no prospect of successful enterprise. Those veins which he possesses dip entirely towards Mr. Brewer's, and besides, they are droppers only, which have been, indeed, entirely worked out; so much so, that every particle of gold ore on the place was ground up before the mine was abandoned.

On Mr. Brewer's side of the stream—although irregularities will certainly be found in the veins, which will render their working more difficult—there is every reason to expect a great improvement in depth, as they become farther removed from the melaphyre dike (which appears here to have exerted very disturbing influences), while the droppers and leaders will increase the size of the main vein.

The main strike of the veins is N. 70° E., the dip N. 20° W. at different angles.

Most work was done on Edgeworth's side, only $2,000 worth of gold having been taken from Mr. Brewer's. The deepest shaft on Edgeworth's land is about seventy feet deep, and extends to the lower termination of one of the droppers worked there.

The clay slate country rock is of a dark and silicious quality. The minor veins which occur in it afford some beautiful specimens, illustrative of shifts and other phenomena which have taken place in veins. Figure 5 on Plate I. exhibits a natural-sized sketch of a double shift of a little vein in a piece of slate from this locality. I have seen no other place, which the student of vein geognosy might so judiciously select to acquaint himself with a variety of the important facts of which that science treats. The fissile character of the country rocks has doubtlessly had its share in rendering these so distinct, while the variety of the minerals—quartz, brown spar, iron pyrites, copper pyrites, and galena—tend to perfect those properties, for whose full development a greater diversity of minerals is necessary.

These are the principal mines, whose veins belong to the first division of the silicious gold veins, which are found in the districts surveyed during the present year. Some veins at the Phiffer mine, those of the old Gardner mine, which now forms a part of the Ingram mine, and, in Chesterfield, the veins of the McInnis and Kirkley mines seem to belong to this division likewise. The latter is in a clay slate country, all the rest in the talcose slate. The veins from which the deposits worked at the Redding mine were derived, judging from the character of the quartz, would appear to be referrible to the same group. They have, however, never been opened.

There are many more, doubtlessly, which have not yet been discovered, while some have been found, but not been explored to an extent which would render their mention here of importance. Among the latter we may particularize the veins on Mr. Rivers' land, near Chesterfield C. H.

The second division of these silicious gold veins comprises those in which *the gangue rock is a saccharoid or sugar quartz.* As the name indicates, it is of a granular kind and resembles loaf-sugar. We find with us, therefore, a similar difference in the quartz with that to which McCulloch has called attention in Scotland. The quartz of these veins sometimes assumes a yellowish color, from the presence of hydrated peroxide of iron, but it is by no means uncommon to find large veins altogether of a pure white. Their size is ordinarily greater than that of the veins of the class just described, but they are far less regular in shape, and—this is a very important and characteristic feature—they uniformly decrease in size downwards, and disappear altogether the moment they strike the hard and undecomposed country rock below, without leaving any thread like trace even, to serve as a leading string for farther explorations. Whether the veins ever again reopen in depth, in which case we might regard them as lenticular ones, has not yet been determined; for the mines have universally been abandoned when the veins first gave out upon coming in contact with the hard rock, accompanied as this usually is by the presence of water, which, strange as it may appear to experienced miners, offers an invincible obstacle to all mining operations with us. These veins are singularly influenced by every change in the ground, a slight increase in hardness always causing them to be "pinched up," as the technical term is. I know of no instance of a total absence of gold in these veins, in the region hitherto surveyed, though the quantity may sometimes be too slight to permit them to be worked with profit. This metal, as found in them, is of a very fine grain, and almost always of a scaly character. It is generally imperceptible to the eye, although the ore be rich. Copper I have but upon two occasions found in veins of this class. This was in the Morgan Dover veins and one of the eighteen-foot veins at the Mary mine.

These veins are probably the most common among all the gold veins of the Atlantic States. They are found as far southwest as the terminus of the crystalline slates of the Alleghanies in Alabama. In the part of this State hitherto surveyed, they are less abundant than they will become in the westward progress of the survey, as they are almost entirely confined to the region west of the south-western and north-eastern prolongation of King's mountain. Thus of the four districts of which this report treats, York is the only one in which they are found, and even in that district they have to a very slight extent only become subjects of mining operations.

Of the veins belonging to this class it will be possible to particularize only those of the southern termination of King's mountain, which were, years ago, slightly explored by Mr. Black; those at the Martin mine, from whose detritus the auriferous gravel deposit worked there was formed; those of Mr. Morgan Dover, which are cupriferous and will therefore be spoken of more at length under the head of copper; and those large (18 foot) veins, which occur at the Mary mine, and will consequently be mentioned in the description of that mine.

We now arrive at the third division of the auriferous true veins, a division which, owing to its extensive distribution in a part of the territory explored this year, as well as on account of its productiveness in gold, occupies a deservedly high rank among the gold veins of the south. I allude to the *lenticular veins, whose chief gangue rock is a hornstone.* These are to be found in Lancaster and Chesterfield, and belong essentially to that talcose slate belt, which lies to the east of the granite of the Waxaws, and is served by the younger granitic and syenitic dike of Taxahaw and Chesterfield. On the north side of this dike—to which many, if not all of them, are probably indebted for their metalliferous contents—this division comprises the succession of mines of Messrs. Stevens, Belk, and Dr. Massey (dec'd), the unexplored mine from which the deposit, which proved so productive to the Brothers Belk, was derived; the Funderburg mine, Knight's mine (in part), Phiffer's mine (in part), and the most southern of the Blackman mines. All of these are in Lancaster, as are, likewise to the south of the dike, the Hail and the Gay mines and the Ingram mine (in part). In Chesterfield we have the Brewer gold mine and the Leach mine.

These veins all present some general features which, though differing but slightly at the various localities, afford modifications quite sufficient to render it possible in most cases to refer the ores to their proper sources as well as to point out diversities in the special conformation of the veins themselves. These local variations render it difficult to give a complete general definition of the main characteristics, owing to the simple fact that these differences are more irregular in this group of veins than in most

others, and that they are modulations of various features. It has been already said that the veins occur in disconnected, lenticular bodies, a fact which of itself already implies variety in form and dimensions. When they show themselves with greater regularity, they appear intimately connected with the rhomboidal jointure planes of the talcose slates in which they occur; so much so, indeed, that it is at first difficult to imagine them true veins and really distinct from the beds of the slate, especially as the mineral composition of the gangue differs from that of the country only in a greater amount of silica. In color, both agree, the vein rock only exhibiting somewhat less opacity than the barren slate.

At the Huey gold mine, in North Carolina, though close to the Lancaster line, we find an admirable illustration of this class of veins, and, as a greater depth has there been attained than at any similar mines in our State, it will be advisable to introduce a short description of it here, for this will explain the character at a greater depth of the same mines with us. At this mine it is extremely difficult to distinguish between the barren slate and the ore. The former is indeed, probably, though a gangue rock, synonymous with the *hyalistire* of Riviere. The ore is characterized by a greater amount of silex, and by its less greasy but more adamantine lustre. It may be properly termed a talcose hornstone. Sometimes it passes into a banded agate, though the color is but little varied, extending only from black to a grayish white. Gold rarely occurs in visible particles, though some specimens have been procured almost coated by the precious metal. The gold is worth but 87½ cents a pennyweight, and the mine is, therefore, in regard to the purity of the gold, far surpassed by some similar mines in our State. Thus, for instance, the gold of the Brewer mine is worth about 102 cents a pennyweight. That we have veins and not beds to deal with at this mine, is evinced by the fact that there is a main vertical body of the auriferous hornstone, towards which the lateral bodies dip. The terrace-like convergency of the leaders towards the main vein is there exhibited in the manner in which the mining explorations have proved it to be the case; for although, at a depth of one hundred and fifty feet, the leaders have not yet joined the main vein, still we must infer that they will soon do so, as they are constantly approaching it. The main vein seems itself to be somewhat lenticular in its shape, as from the surface downwards it first widened to five or six feet, and has now decreased to two. The strike of the vein is N. 65° W., while the dip averages 80°, converging towards the main vein. These veins must remain unexplained, until more protracted mining operations (if continued, as they are at present, progressing under the proprietorship of Commodore Stockton) shall have completely laid bare their features at greater depths. It is a matter of importance to miners as

well as of interest to students of vein geognosy, that the white quartz veins, which abound at the Huey and the adjoining Wiatt mine, and traverse the hornstone veins, never contain a particle of gold, and that, according to Mr. Friedeman's observations, they render the latter equally barren at the point of contact. The same absence of gold exists in the white quartz veins of the Brewer mine in Chesterfield. At Gold Hill in North Carolina, gold is also won from the white quartz veins, though the mine is essentially of the same class as the Huey. This and the Ingram mine are, however, as far as I am aware, the only exceptions.

There are two small dioritic dikes which bisect, but do not interrupt, the auriferous veins, though these are cut off to the north-east by a melaphyre dike.

In our State I have seen no mine of this class in which a sufficient depth has been attained to expose the undecomposed slate; and the analogies, therefore, with the mine just described, must be sought in the upper or older works of the latter, and there we find them very apparent. The auriferous portions are confined, in the upper levels, to silicious and generally also ferriferous parts, which are, however, in such a state of disintegration —owing probably to the former presence of iron pyrites and other oxidizable minerals—that it requires considerable experience before they can be separated from the barren and decomposed slates. This is rendered more difficult because at the commencement, near the surface, these auriferous portions or *pockets*, as the miners term them, are usually of very small dimensions. At the Wiatt mine, which, as far down as the works extend, very nearly corresponds with the Huey mine, Mr. Friedeman, its former superintendent, observed that the auriferous portions were characterized by the dissemination—through the decomposed talco-silicious mass—of a great quantity of minute black specks, which are perhaps crystals of magnetite. These were often the only distinguishing feature between the auriferous and barren rock, as the former is more than ordinarily talcose and the latter highly silicious. Both present but little difference in their general coloring, and are equally friable.

Stevens and Belk's mine is the property of Messrs. Wm. Stevens and T. M. Belk, and is situated seven miles from Lancaster Court House, in a north-eastern direction. It was worked with success for a short time, but, owing to deficiency in a proper knowledge of mining, the work was soon abandoned.

There are several veins, which strike N. 67½° E. The gold contained 85 to 90 per cent. of the pure metal, and even the refuse ore at the mouth of the pits, pans remarkably well.

Thos. M. Belk's mine. The strike of the vein is N. 62½° E.

It was worked pretty successfully by Henry Belk, and like the former, probably only needs a thorough and discreet management to prove productive.

On the north side a melaphyre dike cuts off the vein, and may be expected to enrich it.

Massey's mine is the property of the late Dr. B. C. Massey, adjoining the former. Strike of the vein N. 62½° E., dip 90° N. 27½ W. It was formerly worked by some Englishmen, who sunk a shaft on the vein.

As all three of these mines have been abandoned, the presence of water in the shafts and the great dilapidation of the works, which were originally mostly of a very rude character, prevented an examination of the veins in the shafts and pits; the result of numerous pannings, however, and their geognostic correspondence with those mines more completely opened in North Carolina, and universally admitted to be the most productive and persistent of all their gold mines—ought certainly to cause their resumption.

For a description of the gold veins near the rich deposit worked by the brothers Belk, see Gold Deposits.

The *Funderburk mine* is situated on Lynche's creek in Lancaster, between a dike of the coarse trachytic rock of eastern Lancaster and a peninsular-like portion of the great granitic dike, which has separated from the main body as shown in the map. The granite is seen immediately south of the mine. In composition it is entirely distinct from the syenitic rock of Taxahaw and from the highly felspathic rock of Hanging Rock, being a true granite of a very fine grain and gray color, resembling therefore the enclosed masses of a fine grain in the porphyroid syenite of Taxahaw.

The strike of the veins, or succession of veins at the Funderburk mine is N. 65° E., the dip is on the whole, as far as explored, vertical, though the lenticular veins themselves are individually very variable in dip. A very instructive section of this mine, or rather of a wall of one of the shafts, is represented in Pl. III. fig. 3, where the shaded masses are the lenticular veins. These are, however, not always auriferous at this mine, and the presence of the metal seems confined to the selvages, which is not usually the case in mines of this class. It is not improbable that here the present position of the gold was assumed at a far later period than the formation of the veins, and the time of its original introduction. The gold is generally found in the more cleavable portions of the slate, close to the veins, but, from the fact that it is never present in the slate at any distance from the veins, and that the auriferous slate, from its quartzose character, indicates an introduction into it of a portion of the vein material, it becomes very evident that the origin of the gold is ascribable to the veins and not to beds of the slate. Whether these more schistose and auriferous contact portions of the slates were originally flockans, to which afterwards their peculiar structure was imparted, or whether they are really a part and parcel of the slate, which sub-

sequently received the gold from the veins, is a matter which is at present scarcely possible to determine. At all events we must expect that at greater depth the gold will be found in the veins themselves and not along their margin.

This mine has been abandoned for two years, although a good deal of the ore yielded a pennyweight per bushel. Prior to the revolution a pit was sunk here by a man by the name of Fudge, whose old works are found scattered over Lancaster and Chesterfield, and who, to judge by a shaft of his at the Brewer mine, was a miner by profession, and had previously probably been engaged in copper mines. What he sought, or found here, it is difficult now to establish.

Whether this mine will ever be resumed or not is uncertain. At all events there is but little doubt that its importance, when compared with other mines, is of greater scientific interest than practical value. It is one of the most instructive localities I have seen, in affording explanations and full illustrations of the peculiar and remarkable class of veins of which it is an instance.

Knight's mine, *Phiffer's mine*, and the most southern of the *Blackman's mines* possess veins belonging to this class, but, as they have been but very slightly worked, their internal features have not been sufficiently explored to afford matter of import.

The *Hale mine* is one which merits more than ordinary attention, as well on account of its former productiveness, as the fact that the works having been extensive, it is possible to enter more thoroughly into an investigation of its special characteristics.

The ores of this mine differ more from one another than those of the Brewer mine. This is owing to an occasional far greater abundance of iron pyrites, which occurs in pocket segregations in the veins, and has led to the belief that it indicated the presence of separate pyritiferous veins. Nothing of the kind is, however, the case. This pyrites, notwithstanding its auriferous character, has been thrown aside, as the processes of roasting were not understood. In these heaps a great quantity of sulphate of iron has formed. We also find sulphur in botroidal masses, which, owing probably to the heat engendered by the oxidation of the iron and part of the sulphur, exudes in some places and may be collected in quite a considerable quantity. This formation, or separation of native sulphur serves, likewise, as an explanation of the very common occurrence of this substance in the upper oxidized parts of veins.

In some places, owing to the decomposition of the iron pyrites, the ore is not to be distinguished from the porous and highly friable ore of Stevens and Belk's mine. Regular hornstone is rarely met with, although in depth we may expect to find ores more resembling those of the Brewer.

The deepest work extended to a depth of ninety-three feet. The veins were worked to the lowest levels. The operations

were all exceedingly rude. Indeed the injurious system of renting to small irresponsible companies could induce no well regulated management. Nevertheless, the mine continued for a long period of years exceedingly profitable—the causes for its final abandonment being those only which could not fail to result from the unscientific and ill-judged conduction of the operations. I found a few hands engaged in rewashing the old tailings; but this can scarcely be regarded as reinstating it in the list of operating mines. Still no doubt can exist that at some future day it will be re-opened.

This mine has yielded some nuggets, worth from $300 to $500 each. The metal was found in greatest abundance on the jointure planes, which seem to have offered greater inducement for aggregation. The melaphyre dike was also observed to have exerted a beneficial influence.

Some branch deposits occurred at the mine, which, as long as they lasted, yielded richly.

The Hale mine has evidently been entirely misunderstood by most who have formerly examined it, a fact, which may be ascribed to a want of the means of comparing it with analogous and more fully opened mines.

The *Gay mine*, now belonging to Mr. N. Gay, but formerly known as the little Brewer mine, is a south-western prolongation of the Hale mine veins. It is situated at the very edge of the talcose slate, where this touches the clay slate. The main strike of the lenticular veins is N. 52¼° E., the dip vertical. The country rock has occasionally a slight dip towards the north-west, though generally it is vertical. Towards the east the passage into clay slate is gradual. The latter rock underlies the deposits derived from Gay's veins, which have formerly been worked on Mr. Todd's land. The strike of this clay slate is here N. 44° E, the dip 45° S. 46° E. Todd's mine was formerly called the Lanier. Nuggets of some size were found here, but the deposit is now pretty well worked out. Good management might still, perhaps, render the veins of the Gay mine profitable, although they are very contracted in comparison with those of the Hale.

The *Ingram mine.*—The work which has been done here is confined to a white quartzose vein, and the deposits formed from it, and, in this part, was formerly known as the Gardener mine.

This mine is interesting as affording one of those very rare instances of auriferous white quartz veins, accompanying auriferous hornstone lenticular veins. The latter veins are a direct continuation of those at the Brewer mine, which are covered by the clay slate (therefore older than it) on the road from Taxahaw to that mine. They present at both localities the same features, and contain alike iron pyrites and the new mineral found at the Brewer mine. These lenticular veins have as yet not been explored, ought they certainly merit the utmost attention.

South of the succession of lenticular veins lies the white quartz vein formerly worked. They are about fifty feet apart. The latter strikes north-east. It does not exceed six to eight inches in width. Its small size, therefore, precludes the possibility of deep mining. This is not the case with the unopened lenticular veins, with regard to which the fact of their never having been injured by ruinous mining operations, will add much to their value when they are worked at some future day.

The *Brewer mine* is situated on Lynche's Creek in Chesterfield district. As there are various points of interest connected with it, which have long called attention to its geognostic conformation, we cannot avoid experiencing some surprise that this should have been so completely misinterpreted by former observers, although there are a variety of reasons why this mine should have been so difficult to decipher, and why its somewhat complex character should have led to misconceptions. Like the Hale mine, it has never been viewed in connection with mines of a similar character; partly probably from the fact that the unusual and certainly very great size of the lenticular veins rendered a comparison somewhat difficult; partly because the highly disintegrated state of both gangue and country placed obstacles in the way of their separation and exact distinction; but principally, in all probability, because a most savage and wasteful treatment of the mine, the natural consequence of the injurious policy pursued with regard to it, has introduced such utter confusion, that an attentive and protracted investigation can alone establish its true character. It is not impossible, also, that its separation from most other mines of the same class, by the syenitic dike, may have induced misconstructions.

The strike of all the lenticular veins as well as their dip corresponds with that of the slates, the former being N. 70°–72° E., the latter 60°–63½° N. 18°–20° W. Their width is from twenty to thirty feet, and sometimes even extends to fifty.

The hornstone of these veins in its original state is blue, though varying, in depth of coloring, from indigo to sky-blue. It is, however, even on the Blue Flint Hill, not often met with in its undecomposed state, and, when it does occur, is generally found only in the central parts of the lenticular veins, where it exists in the shape of kidney-like masses. The disintegration of the hornstone is assisted, if indeed it be not caused, by the presence in it of iron pyrites, not unfrequently with the accompaniment of copper, and a new mineral,* which, though never found in large crys-

* This mineral, which, as stated above, appears to be new, contains, from a hasty blowpipe examination made in camp, copper and arsenic. Professor Dana of Yale, has kindly undertaken to examine it. Should the results of his observations arrive before the publication of this report they will be appended in a note. Before testing the mineral, I was inclined to consider it tetrady-

tals, occurs in considerable abundance. All these are disseminated through the gangue, and, in the first stage of disintegration, produce partial porosity and a discoloring of the rock, which then assumes a reddish cast, more or less intense according to the quantity of oxide of iron present. In the centre of these pinkish masses, we find a kernel of the blue hornstone, sometimes many tons in weight. A farther disintegration results in the production of a sand, of a fineness of grain so nearly impalpable that it reminds us of the remains of silicious infusoriæ, which are employed for polishing plate, and which constitute, for instance, the infusorial slate of Bilin, in Bohemia. At this stage of disintegration it is impossible to lay down the boundary line between it and the decomposed, highly silicious, talcose slate country rock, as both are then equal in color (white) and texture, and the talcose ingredient of the slate is rarely in a shape admitting of ocular detection.

The whole mass of the hornstone gangue is auriferous, although the gold is often inattainable by the simple and inefficient means of extraction employed, as well on account of the hardness of the ore, the fineness of the gold in grain, as the intimate association of the latter with the iron pyrites.

The gangue rock of the veins is traversed by the same jointure planes, which show themselves in the slates. These are usually richer in gold than other portions, and it can, therefore, not surprise us that the miners, ignorant of the true nature of the mine, should term them veins. I have found them of very different strike and dip. Thus at Baker's whim shaft, on the most southern of the two summits of the Blue Flint Hill, some dip 60° N., others 26° S., and again others N. E. At other parts of the mine there are such seams striking N. 35° W., dipping vertically or N. E. 60°–75° and S. W. 75° to 90°, N. 75° E., S. 15° E. 45°. Among the latter, the second one alone contained no gold. Many of the fissures have very evidently been filled from above, so that, in these cases, the presence of the gold is ascribable to surface washings. This may be observed with great distinctness, just above the extensive deposit known as the Old Tan Yard, where a seam of a vertical dip is auriferous and another dipping more horizontally is perfectly barren. A matter connected with this washing in from above is the fact that very frequently soft disintegrated masses of a highly auriferous character are found beneath undecomposed parts of the vein, having found their way in from above. The washing, which occasioned it, at the same time effected a concentration of the ore, so that it now proves richer than the rest.

mite (consisting of bismuth and tellurium), as Dr. Genth found a trace of tellurium in the carbonate of bismuth from this mine. Its first discovery is due to Mr. Friedeman.

Numerous barren white quartzose veins of every possible strike and dip traverse the hornstone veins and the slates without any regularity, but with great frequency of occurrence. The hornstone veins are sometimes cut off by them, although their size rarely exceeds one foot. These render the mine what German miners term a "Truemmerstock."

The Tan Yard where the first gold won at this mine was made, is exclusively a deposit, resulting from the disintegration and washing away of the upper parts of the veins to the north of it. It thus affords an instance of the fact, already once alluded to, that deposits arising from the attrition of veins, should be sought on their foot wall side. To the south of the Tan Yard, another series of lenticular veins occurs, which cannot, however, have assisted in the formation of this deposit, though it may have furnished a part of the gold which was found in the southern continuation of the deposit. The hornstone of these veins, being in a less advanced stage of disintegration, is harder than that of the rest, to which it is probably ascribable, that they have never been worked. A compact breccia, cemented by iron, underlies the Tan Yard deposit.

Although this mine has been in operation for a far longer period than any other in the State, and every branch, bed, gulch, ravine or even declivity of the main hill, has been washed and rewashed, and although the whole surface is torn up in the most extraordinary manner, and a depth of from sixty to seventy feet attained, yet they have never struck the undecomposed talcose slate, while the veins themselves, with the exception of unimportant central portions, were equally disintegrated.

Mr. Tuomey, in his report, already speaks of the ruinous effect, which the system of letting to small, irresponsible companies had even then exerted upon this mine. Successive years have increased the injurious results. The mine itself has probably few equals, and, on account of the quantity and purity of its gold, the minerals accompanying it (see Bismuth), the great number of miners (several hundreds at one time) once employed here, occupies a position of singular interest among the mines of South Carolina. The plan pursued by the proprietors was, however, the best which could have been selected to ruin it. They were in the habit of letting out small lots, the stakes of whose boundaries are still left in some places as memorials of the imprudent policy pursued, if indeed the present state of the mine did not sufficiently illustrate and prove its evils. This process, commencing at the Old Tan Yard deposit, was continued on the Blue Flint Hill, and the pits were sunk by the side of one another, without any regard to security or stability, each lot being worked independently and without any reference to neighboring ones. Hardly any regular shafts were sunk, and huge excavations meet the eye scattered about in the utmost confusion.

The amount of labor here so wastefully expended, if guided by proper knowledge and constrained within the bounds of moderation, would doubtless, by this concert of action, have produced results, whose beneficial effects would long have been felt. As it is—although at one time the productiveness of the mine was so great, that the laborers slept by their pits with loaded rifles—now a few scattering individuals can scarcely gain a scanty livelihood. This is in part caused by the extravagant rent which the miners are, by contract, obliged to pay. The gold contains 986 parts in a thousand of pure gold, and is therefore worth about $1.02, per pennyweight. Yet the miners, who are required to sell it to the agent, receive but 72 cents a pennyweight for it, as I am informed, paying, therefore, nearly 30 per cent. as rent. This of course excludes all but the most needy. As a natural consequence, those only are to be found there, who have not the means to avail themselves of the advantages afforded by machinery. This, indeed, has been formerly even but sparingly employed here. Chilian mills and arastres were used it is true, but "long Toms" and rockers were chiefly employed. The latter only are now in use at the mine. Steam-power was never applied; yet it is this alone, which, by enabling the ores to be taken, rank and file, as they come, can ever redeem the mine. It is to be hoped that a day may arrive, when it will be taken in hand by competent men, supplied with ample means, and then there is little room to fear that it will be found wanting in productiveness.

A statistical view of the amounts of gold taken from this mine since it was first opened, would have been exceedingly interesting, but I regret to say, that the chief proprietor, Mr. Brewer, guided by motives of which I am not cognizant, was unwilling that this should be made public.

The *Leach mine* is also in Chesterfield district. Its importance is, however, but slight, although its geognostic character obliges us to class it with the Brewer mine. It has been worked to a slight extent only.

There are still some gold vein mines remaining, which, though differing considerably in themselves, cannot be properly classed with any of the foregoing ones. The mine, which occupies the most important position among these, is undoubtedly the *Izell mine.*

This is situated in the north-western part of Lancaster district immediately adjoinging the North Carolina line, where the granite of the Waxaws enters that State. It is not impossible that explorations, continued to a greater depth, may discover this mine to belong to the lenticular vein mines, though the white quartz of these veins would indicate a different character. The mine was at one time pretty extensively worked, although the operations were confined to portions but little removed from the surface. It was found that a melaphyre dike, which occurs here, three feet

in width, striking N. 28° W., and, therefore, cutting the veins, materially increased their productiveness. The main strike of the veins is N. 70° E., although I found some striking N. 37½° W.

The *Johnston mine*, also in Lancaster, situated pretty centrally in that district, differs entirely from the Izell.

The gold-bearing seam is somewhat funnel-shaped, and very nearly gives out at the lowest point of observation. The matrix of the precious metal is of a talcose slate character and may possibly originally have been a flockan, the gold in which was derived from higher portions of the quartz vein. At a point lying higher than the mouth of the shaft, gold even now occurs in the vein, although none is found in it at the pit.

The quartz of the vein would induce us to place it in the first class of gold veins, were it not that the presence in it of pyrolusite, an ore of manganese (visible at a part exposed by an old pit, sunk three-quarters of a century since by Fudge), distinguishes it from any of that class hitherto observed. It may be, however, that, in this instance, this mineral occupies the position otherwise taken by lead ores, for the character of the quartz affords inducement to expect the presence of copper at depths hitherto not attained.

The size of the quartz vein is two feet, its strike E. and W. at the shaft, at the Fudge pit 75° W. The dip is 45° S., while the slate dips to the north. The gold vein is one foot from the quartz vein, and about one foot in diameter. It is a noticeable fact, that wherever the quartz vein approached the gold seam, or where quartzose leaders traversed it, the gold was found to have disappeared.

The depth of the shaft is seventy feet. Water, foul air, and the contraction of the gold seam were the causes of the abandonment of the mine two years since.

Thus far auriferous *veins* alone have received our attention. The metal, as previously remarked, however, occurs also in other ways. Among these the *auriferous slate beds* are the first to be discussed. The only kind of slate, in which I have hitherto found gold-bearing strata in our State, are the talcose and clay slates. In Alabama I observed a silicious hornblendic slate, which also contained this metal and had been worked to a considerable extent. Two mines only of this description can be mentioned here, the Blackman mine in Lancaster, and the Hendrix mine, in Chesterfield.

The *Blackman mine*, is situated about a mile and a half north of another mine of the same name, mentioned under the head of the hornstone veins.

The slate is an almost pure talc, of a color which passes from silvery whiteness to a rich fawn and a bright green. The presence of minute silicious accumulations, about three-tenths of an inch in diameter, has locally given it a wavy appearance. These

diminutive quartzose nodules occur in the seams, which were found to abound most in gold, although they are not absolutely indicative of the metal, for I observed some of the same kind of slate which contained not a particle. The auriferous strata are generally the most brilliantly green of all, though sometimes a grayish stratum is found to contain gold likewise. A rule with regard to either of these distinctions, it is, therefore, impossible to make. It was only by following certain beds, that the miners were able to separate the ore from the attle. That portions of the vein were found less remunerative, is simply ascribable to the fact, that less compression of the strata resulted in a less perfect concentration of the ore. Could it have been possible to have ascertained the average specific gravity of the two parts of the same beds, before lateral pressure ensued, that of both would probably have been found the same; while, with equal probability, a difference would have been discernible after the pressure took effect, but, before disintegration and decomposition had converted the beds into their present shape.

A deposit, where very coarse gold occurs, has formed from the abraded portions of the slate, and has been worked to a considerable extent. Money might yet be made there, some of the ore yielding, as estimated from panning, $2 per bushel. A few large nuggets were found at this place.

This mine has been pretty thoroughly exhausted. The operations extended to a depth of from ninety to ninety-four feet. Mr. Henry Gardner was the one who worked it chiefly, indeed, till within five years. The deposit was worked by others long before.

The gold in the slate is very fine in grain, and is worth over a dollar per pennyweight.

The strike of the slate is N. 77½° to 80° E., the dip 58° N. 10° to 12°½ W., although, as the sections show, the latter is variable.

The place is situated about two miles south of Mt. Croghan. As yet it has been but very sparingly worked (by a Mr. Talmadge), but it is hoped that farther explorations will be made, as this mine is certainly the only known instance of the kind in the United States, perhaps in the world.

Gold Deposits.—This is the third and last division of the natural occurrences of gold in the part of the State surveyed this year. They are secondary accumulations of gold, in depressions, or along water courses, the gold being derived from veins or beds.

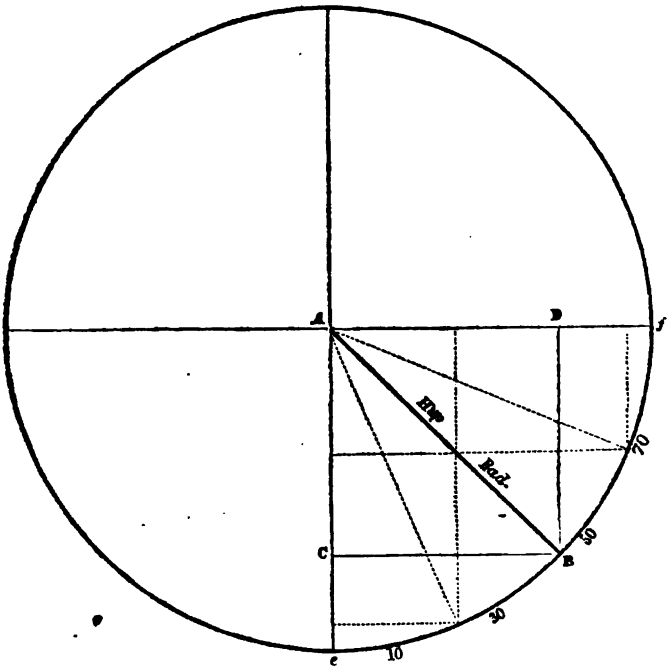
The Atlantic and Gulf States possess no deposits of an extent, which can entitle them to the importance attaching to those in California, Australia, Africa, and Siberia, but yet there are some in our State, which cannot be omitted in this report.

(To be continued.)

ART. II.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 5.

(Continued from page 526.)

FIRST TABLE.—HYPOTHENUSE RADIUS, ONE FATHOM.



ANGLE.		BASE.			PERPENDICULAR.				
Deg.	Min.	Feet.	Ins.	Decimals.	Feet.	Ins.	Decimals.	Deg.	Min.
	1	0	0	·02094	6	0		89	59
	2	0	0	·04189	6	0		89	58
	3	0	0	·06283	6	0		89	57
	4	0	0	·08387	6	0		89	56
	5	0	0	·10482	6	0		89	55
	6	0	0	·12576	6	0		89	54
	7	0	0	·14670	6	0		89	53
	8	0	0	·16765	6	0		89	52
	9	0	0	·18859	6	0		89	51
	10	0	0	·20943	6	0		89	50
	11	0	0	·23038	6	0		89	49
	12	0	0	·25132	6	0		89	48
	13	0	0	·27225	6	0		89	47
	14	0	0	·29319	6	0		89	46
	15	0	0	·31414	5	11	·99938	89	45
	30	0	0	·62831	5	11	·99726	89	30
	45	0	0	·94245	5	11	·99381	89	15
PERPENDICULAR.					BASE.			ANGLE.	

ANGLE.		BASE.			PERPENDICULAR.				
Deg.	Min.	Feet.	Ins.	Decimals.	Feet.	Ins.	Decimals.	Deg.	Min.
1		0	1	·25657	5	11	·98903	89	
	15	0	1	·57067	5	11	·98286		45
	30	0	1	·88474	5	11	·97532		30
	45	0	2	·19877	5	11	·96664		15
2		0	2	·51276	5	11	·95614	88	
	15	0	2	·82666	5	11	·94249		45
	30	0	3	·14060	5	11	·93147		30
	45	0	3	·45442	5	11	·91708		15
3		0	3	·76819	5	11	·90132	87	
	15	0	4	·08188	5	11	·88420		45
	30	0	4	·39549	5	11	·86571		30
	45	0	4	·70902	5	11	·84584		15
4		0	5	·02246	5	11	·82461	86	
	15	0	5	·33581	5	11	·80201		45
	30	0	5	·64905	5	11	·77805		30
	45	0	5	·96219	5	11	·75272		15
5		0	6	·27521	5	11	·72602	85	
	15	0	6	·58811	5	11	·69793		45
	30	0	6	·90090	5	11	·66853		30
	45	0	7	·21354	5	11	·63773		15
6		0	7	·52605	5	11	·60558	84	
	15	0	7	·83842	5	11	·57205		45
	30	0	8	·15063	5	11	·53718		30
	45	0	8	·46269	5	11	·50093		15
7		0	8	·77459	5	11	·46333	83	
	15	0	9	·08633	5	11	·42435		45
	30	0	9	·39789	5	11	·38403		30
	45	0	9	·70926	5	11	·34234		15
8		0	10	·02046	5	11	·29930	82	
	15	0	10	·33147	5	11	·25490		45
	30	0	10	·64228	5	11	·20914		30
	45	0	10	·95288	5	11	·16203		15
9		0	11	·26328	5	11	·11356	81	
	15	0	11	·57347	5	11	·06[illegible]74		45
	30	0	11	·88343	5	11	·01256		30
	45	1	0	·19316	5	10	·96104		15
10		1	0	·50267	5	10	·90616	80	
	15	1	0	·81193	5	10	·85093		45
	30	1	1	·12096	5	10	·79435		30
	45	1	1	·42973	5	10	·73643		15
11		1	1	·73825	5	10	·67716	79	
	15	1	2	·04650	5	10	·61654		45
	30	1	2	·35449	5	10	·55458		30
	45	1	2	·66221	5	10	·49128		15
12		1	2	·96964	5	10	·42663	78	
	15	1	3	·27680	5	10	·36062		45
	30	1	3	·58365	5	10	·29331		30
	45	1	3	·89021	5	10	·22464		15
13		1	4	·19648	5	10	·15465	77	
	15	1	4	·50243	5	10	·08331		45
	30	1	4	·80807	5	10	·01062		30
	45	1	5	·11338	5	9	·93663		15
14		1	5	·41838	5	9	·86129	76	
	15	1	5	·72204	5	9	·72304		45
	30	1	6	·02736	5	9	·70663		30
	45	1	6	·33134	5	9	·62730		15
15		1	6	·63497	5	9	·54666	75	
	15	1	6	·93825	5	9	·46469		45
	30	1	7	·24116	5	9	·38139		30
	45	1	7	·54371	5	9	·29677		16
16		1	7	·84589	5	9	·21084	74	
	15	1	8	·14769	5	9	·12359		45
	30	1	8	·44910	5	9	·03502		30
	45	1	8	·75014	5	8	·94514		15
17		1	9	·05076	5	8	·85395	73	
	15	1	9	·35099	5	8	·76143		45
	30	1	9	·65082	5	8	·66762		30
	45	1	9	·95023	5	8	·57250		15
18		1	10	·24922	5	8	·47607	72	
	15	1	10	·54779	5	8	·37833		45
	30	1	10	·84594	5	8	·27931		30
	45	1	11	·14364	5	8	·17897		15
PERPENDICULAR.					BASE.			ANGLE.	

ANGLE.		BASE.			PERPENDICULAR.				
Deg.	Min.	Feet.	Ins.	Decimals.	Feet.	Ins.	Decimals.	Deg.	Min.
19		1	11	·44091	5	8	·07734	71	
	15	1	11	·73772	5	7	·97441		45
	30	2	0	·03409	5	7	·87019		30
	45	2	0	·33000	5	7	·76467		15
20		2	0	·62545	5	7	·65787	70	
	15	2	0	·92048	5	7	·54977		45
	30	2	1	·21493	5	7	·44040		30
	45	2	1	·50895	5	7	·32973		15
21		2	1	·80249	5	7	·21779	69	
	15	2	2	·09554	5	7	·10457		45
	30	2	2	·38809	5	6	·99007		30
	45	2	2	·68013	5	6	·87429		15
22		2	2	·97167	5	6	·75724	68	
	15	2	3	·26270	5	6	·63892		45
	30	2	3	·55320	5	6	·51932		30
	45	2	3	·84320	5	6	·39847		15
23		2	4	·13264	5	6	·27635	67	
	15	2	4	·42156	5	6	·15297		45
	30	2	4	·70993	5	6	·02833		30
	45	2	4	·99776	5	5	·90243		15
24		2	5	·28503	5	5	·77528	66	
	15	2	5	·57176	5	5	64686		45
	30	2	5	·85791	5	5	·51721		30
	45	2	6	·14350	5	5	·38631		15
25		2	6	·42852	5	5	·25416	65	
	15	2	6	·71295	5	5	·12077		45
	30	2	6	·99680	5	4	·98614		30
	45	2	7	·28·06	5	4	·85027		15
26		2	7	·56272	5	4	·71317	64	
	15	2	7	·84479	5	4	·57483		45
	30	2	8	·12622	5	4	·43528		30
	45	2	8	·40708	5	4	·29448		15
27		2	8	·68732	5	4	·15247	63	
	15	2	8	·96692	5	4	·00923		45
	30	2	9	·24590	5	3	·86478		30
	45	2	9	·52424	5	3	·71911		15
28		2	9	·80195	5	3	·57223	62	
	15	2	10	·07902	5	3	·42413		45
	30	2	10	·35543	5	3	·27483		30
	45	2	10	·63120	5	3	·12433		15
29		2	10	·90630	5	2	·97262	61	
	15	2	11	·18073	5	2	·81972		45
	80	2	11	·45450	5	2	·66561		30
	45	2	11	·72759	5	2	·51031		15
30		3	0	·00000	5	2	·35383	60	
	15	3	0	·27173	5	2	·19616		45
	30	3	0	·54276	5	2	·03730		30
	45	3	0	·81310	5	1	·87726		15
31		3	1	·08274	5	1	·71605	59	
	15	3	1	·35168	5	1	·55866		45
	30	3	1	·61990	5	1	·39009		30
	45	3	1	·88740	5	1	·22536		15
32		3	2	·15419	5	1	·05946	58	
	15	3	2	·42024	5	0	·89240		45
	30	3	2	·68557	5	0	·72418		30
	45	3	2	·95016	5	0	·55481		15
33		3	3	·21401	5	0	·38428	57	
	15	3	3	·47711	5	0	·21261		45
	30	3	3	·73946	5	0	·03978		30
	45	3	4	·00105	4	11	·86581		15
34		3	4	·26189	4	11	·69071	56	
	15	3	4	·52195	4	11	·51446		45
	30	2	4	·78125	4	11	·33709		30
	45	3	5	·03977	4	11	·15858		15
35		3	5	·29750	4	10	·97894	55	
	15	3	5	·55445	4	10	·79819		45
	30	3	5	·81062	4	10	·61632		30
	45	3	6	·06598	4	10	·43333		15
36		3	6	·32054	4	10	·24929	54	
	15	3	6	·57429	4	10	·06401		45
	30	3	6	·82724	4	9	·87770		30
	45	3	7	·07987	4	9	·69027		15
PERPENDICULAR.					BASE.			ANGLE.	

ANGLE.		BASE.			PERPENDICULAR.				
Deg.	Min.	Feet.	Ins.	Decimals.	Feet.	Ins.	Decimals.	Deg.	Min.
37		3	7	·33068	4	9	·50176	53	
	15	3	7	·58117	4	9	·31214		45
	30	3	7	·83082	4	9	·12144		30
	45	3	8	·07965	4	8	·92965		15
88		3	8	·32763	4	8	·73678	52	
	15	3	8	·57476	4	8	·54288		45
	30	3	8	·82105	4	8	·34779		30
	45	8	9	·06649	4	8	·15168		15
39		3	9	·31107	4	7	·95451	51	
	15	3	9	·55478	4	7	·75627		45
	30	3	9	·79768	4	7	·55697		30
	45	3	10	·03961	4	7	·35661		15
40		3	10	28071	4	7	·15520	50	
	15	3	10	·52093	4	6	·95274		45
	80	3	10	·76026	4	6	·74923		30
	45	3	10	·99871	4	6	·54468		15
41		3	11	·23625	4	6	·33909	49	
	15	3	11	·47290	4	6	·13346		45
	30	3	11	·70864	4	5	·92481		30
	45	3	11	·94348	4	5	·71618		15
42		4	0	·17740	4	5	·50643	48	
	15	4	0	·41041	4	5	·29570		45
	30	4	0	·64250	4	5	·08396		30
	45	4	0	·87365	4	4	·87122		15
43		4	1	·10388	4	4	·65747	47	
	15	4	1	·33318	4	4	·44271		45
	30	4	1	·56153	4	4	·22696		30
	45	4	1	·78894	4	4	·01021		15
44		4	2	·01540	4	3	·79247	46	
	15	4	2	·24092	4	3	·57374		45
	30	4	2	·46547	4	3	·35403		30
	45	4	2	·68906	4	3	·13335		15
45		4	2	·91169	4	2	·91169	45	
PERPENDICULAR.					BASE.			ANGLE.	

(To be continued.)

ART. III.—A SKETCH OF THE GEOLOGY OF TENNESSEE.—By R. O. CURREY, M. D., Knoxville, Tenn.

(Continued from page 460, vol. viii.)

EAST TENNESSEE.

Geological Sketch.—There is not found in the Union a more interesting field of the same extent for geological observation than is afforded in East Tennessee. This is true, not only with reference to the vast numbers of useful minerals imbedded in its strata, and the great quantity of some of them, but also to the complicated arrangement and peculiar character of its rock strata.

In describing, therefore, the formations existing here, and their economical applications to the wants of society, I will begin at a point in the State line on the Smoky Mountains, where it intersects with the Georgia line. From this point draw a line in

a N. W. course to Knoxville, thence N. E. to Tazewell, thence N. W. to the Cumberland Gap, and every important stratum will be passed over. On this summit of the Smoky Mountains there are to be found the primordial rocks, consisting of granite, gneiss, mica slate, talcose slate, and quartz rock, containing imbedded crystals of actynolite and garnet. These primordial rocks are not traceable exactly on the boundary line between this State and North Carolina, but sometimes deviating to one side and then to the other. Dr. Troost, with whom I had the pleasure in 1839 of tracing out a portion of this line of demarcation, thus describes these strata in his fifth Geological Report:

"In Carter county the primordial rocks are found ten or twelve miles west of the line; the whole of Roane Mountain is composed of granite rocks. The primordial mountains then diminish, and about the head waters of Indian Creek are no more to be seen in that part of Tennessee. The State line then runs over the grauwacke formation or group, till near Wolf Creek in Cocke county, where the primordial rocks again enter Tennessee. The high ridge of the great Smoky Mountains is granitic till about the entrance of Tennessee River into Monroe county, where the grauwacke group again makes its appearance, continuing along the Unaka Mountains to M'Minn county. Here again the primordial rocks enter the State, and continue on to Amoee River, where they are replaced again by the grauwacke group.

"Towards the east of the high ridge of the Appalachian chain, the primordial rocks generally prevail. This high ridge, which separates these formations and which contains in its limits the highest mountains of the United States, is sometimes composed of granite and gneiss, as Roane Mountain; sometimes of a granite, which contains talc and chlorite or protogene; sometimes of a talcose rock containing actynolite. It contains also some veins of magnetic oxide of iron, as the Cranberry ore in Carter county, which is associated with *Pyroxene Sahlite*, as in some of the Swedish iron ore—or is not associated with any other mineral, as in Cocke county."

Where we begin our reconnoissance, they cross the mountain, and on the western descent we soon enter upon a series of sandstones and shales and slates of a primitive or metamorphic character. These strata are found to possess an inclined position, the dip being inwardly S. E. to the centre of the mountain, giving the appearance to the primordial rocks, which they actually do, of overlying these stratified rocks. The dip of these strata being to the E. S. E., the strike or course of the upturned edge is from W. S. W. to E. N. E., observing the general direction of the mountain range. But continuing our descent to the west, when we have reached the base of the mountains, we come upon a series of strata belonging to a more recent date, and affording the characteristic fossils of the Silurian period. These consist of various limestones with interstratified shales and sandstones. And as a general rule, if we start from a point near the Frog Mountains on the Georgia line, and take an E. N. E. course, we may trace out the line of separation between the metamorphic slates of the Unaka group, and the limestones and other strata of Silurium formation. Thus as we continue our course to the N. W. from this mountain range, we come next upon a stratum of lime-

stone composed of fragments of several shades of gray and black, with white veins, cemented together with the same substance, forming a beautiful breccia marble, then to a hard magnesian limestone, and then successively over the uplifted edges, and at right angles to the course of each stratum, till we have passed about five miles to the N. W. of Tazewell. To this point, each stratum of rock, whatever might be its character, is found to possess similar dips and courses, the angle of inclination being about 45 degrees—unless in a few localities where silicious veins have evidently been forced up through the disrupted rock strata. But a new arrangement presents itself at the point alluded to. As it is approached the strata are found to become less inclined, until at last they have assumed the *horizontal* position. This *anticlinal* axis is about three miles wide, and composed of a hard magnesian limestone, very fully intermingled with chert rock; in fact this latter imparting to the former quite a silicious character. The strata to the N. W. of it dip in an opposite direction—gradually inclining to an angle of 45 degrees and more, until they are lost under the Cumberland Mountains.

This axis and these opposed strata, possess the same course as those previously described. To illustrate this, take a book, and, partially opening it in the middle, place it upon a table on its edge, the horizontal back will represent this anticlinal axis, and the leaves, the strata inclined against each other. The strata on each side of this axis are identical in every respect. It may be traced from the base of the Cumberland Mountain to the north of Clinton in an E. N. E. direction into Virginia. The stratum which composes the axis is found in several other localities through East Tennessee. I have found it in some places so disintegrated by the washing out of the limestone that the mass which remained, consisted almost entirely of white sand. As yet I have discovered no traces of organic life in it; but its character may be readily determined by its crystalline disposition, there being observed frequent minute rhomboidal crystals, either projecting or being washed out and leaving the same regular cavity.

In addition to this axis, several others are found, but generally they are local, limited in extent, but nearly all of them are composed of the same stratum. There is one about 15 miles to the west of Knoxville, in which the opposing strata are found on opposite sides of a narrow valley, each dipping outwards, and tending to unite by an imaginary line about midway of the valley. Another limited axis is found on the north of Clinch River; the strata here in fact presenting quite a disturbance, twisted and broken up in various places. At the Chattanooga quarry, and in the Lookout range, there is also a singular distortion in the strata, the quarry at Chattanooga, and the strata composing the mountain dipping to the south-west, and of course lie inconformably with other stráta in towards the Raccoon Mountains. As the

greater number of these axes are composed of this hard magnesian limestone, with chert or silicious interstratifications, it may be regarded as the lowest or oldest member of the silurian rocks in East Tennessee, and that it lies immediately upon the Unaka slates and shales.

Its position with reference to the other strata of East Tennesse, is in the following order:

1. Unaka granite, gneiss, mica slate, quartz rock and sandstone.
2. Aluminous slates and talcose slate.
3. Magnesian limestone with veins of chert or silex.
4. Magnesian limestone with semi-crystalline veins of calcareous spar.
5. Blue fossiliferous limestone.
6. Red and grayish argillaceous limestone interstratified with hydraulic limestone.
7. Shales and sandstone underlying the coal measures of the Cumberland Mountains.

These seven different strata may be passed over at several points in passing along our line of reconnoissance. And the casual observer would overlook the regular order in which they invariably occur. But though there are only these seven peculiar strata, yet there are not less than fourteen such series, making altogether through the valley of East Tennessee not far from forty strata of rock. What caused this disruption? and how is this regularity obtained? We may imagine the rock strata of this whole district once to have possessed a horizontal position, and violent subterraneous action, being exerted in right lines, in a N. E. and S. W. direction, broke up and elevated the strata all along that line where the force was expended. We can suppose this force to have been exerted whenever one series of rock changes for another, and to have been of just that degree to have elevated the strata to an inclination of 45°, thus producing in fact a succession of *faults*, to speak in the language of miners.

Now to solve this problem of their formation, we have but to cast a glance at the physical configuration of the country. Here is a valley, bounded on the east and west by parallel ranges of mountains of different geological periods, yet the origin of both attributable to violent subterranean action. The Unaka Mountains on the east consisting of the primordial rocks, of course are readily admitted as being beneath the fossiliferous strata of East Tennessee, while this lies underneath that of the Cumberland Mountains on the west. Now how is it that these Unaka granites and slates are tilted up, and apparently reclining upon the limestones of the valley? This can be only explained on the theory of these faults by local action. They do not present the appearance of being disrupted in that way to produce similar strata on each side of the line of action, for then there would appear a suc-

cession of anticlinal axes wherever the force was expended. Neither are there any synclinal axes of any extent to be found, setting at rest any idea as to a depression at any point opposed to the force of elevation. This force then acted in such a way as to break the strata and elevate one end of the fragment, while the other remained stationary, and elevating it too to that height that the adjoining fragmentary strata would seem to underlie it. Then again the Cumberland range, constituting an immense coal field, now elevated to a height of more than 1,000 feet above the level of the country, doubtless was once an extensive inland lake, in which all the animals and plants of the carboniferous era lived and flourished, extending from the interior of Alabama to New York. But at the time of these volcanic disruptions, the bed of this lake was elevated, it may be, gradually, to its present altitude, the waters being drained off, and an immense coal field provided for the benefit of man, the last great act of Creative Power.

Thus the mountain ranges on either side, as well as those of less altitude in the valley, and the valley itself, with its streams and rock strata, are all parallel, possessing a N. E. and S. W. course.

Observe moreover the uniformity with which the members of each series succeed each other. Thus supposing we indicate the above strata by figures, we have in one series 4, 5, 6, 7, in the adjoining 4, 6, 7, in the next 4, 5, 6; but never any reverse order as 7, 6, 5, 4. This regularity is of decided advantage, especially in those strata which can be applied to the wants of society. It enables the quarrier to trace out a stratum, or the miner to sink shafts without an useless expenditure of time and money. Two instances may be adduced. The strata, mica slate and quartzose sandstone with gossan, in which the copper of the Ocoee District is found, partake of this same general inclination and a direct E. N. E. course. The miner therefore reckons his distance for sinking his shaft through the overlying strata, and can readily trace out the course of the vein. And again, No. 4 in the series of rocks is a valuable stratum of marble which is found to occur *five times* in our line of observation, namely, near the base of Chilhowee Mountain, one mile south of Knoxville—one mile north of Knoxville—north of Clinch Mountains, and near Tazewell. Possessing the same E. N. E. course with the other strata, each one may be traced out in its entire length. Take the stratum, for instance, north of Knoxville, and it is the same found at or near New Philadelphia, and near Rogersville. It is supposed by some that there are different strata of different colored marbles, but I am inclined to the belief that these different colors are but layers of the same stratum, and that the reason why the marble is found red at one place, white at another, and blackish at a third, is due only to the partial appearance of these different layers. So inexhaustible in quantity, and acknowledged

by competent judges, at the New York Industrial Exhibition and at the Capitol at Washington, to be of an unrivalled quality, there are only needed the facilities of transportation to render this a source of enterprise and wealth.

Mineral Resources.—The minerals which are to be found in East Tennessee are the following: Sulphate of Barytes, Sulphate of Lime, Carbonate of Lime, Arragonite, Marbles of various colors, Nitrate of Lime, Sulphate of Magnesia, Magnesian Carbonate of Lime, Alum, Wavellite, Silica, Talc, Chlorite Slate, Hornblende, Garnet, Felspar, Porphyry, Mica Slate; and of ores, we have Magnetic Oxide of Iron, Hydroxide of Iron, Scaly Oxide of Iron, Native Iron, Arsenical Iron, Sulphuret of Iron, Carbonate of Zinc, Sulphuret of Zinc, Sulphuret of Lead, and Black Oxide, Red Oxide, Green Carbonate, Silicate, Gray and Yellow Copper Pyrites and Native Copper, Gold and Silver.

I will describe each of these in the order in which I have named them.

Sulphate of Barytes.—In many localities, sometimes alone and always associated with lead, is to be found a heavy rock of various colors—white, yellowish, blue, red and brown. It is the heavy spar, or sulphate of Barytes. The white variety is used for grinding up into a white paint, and probably the red, brown and blue would answer for the same purpose. As a paint, it affords rather a dull earthy lustre, and soon tarnishes. It is much used for adulterating white lead, and when this pigment does not give a glossy smooth coat, it may be presumed to be more or less adulterated with this mineral. Specimens have been obtained from the following localities: the *blue* variety from Sullivan co., near Kendenet's Creek: yellowish crystallized variety, from Powell's Valley below Tazewell; reddish white from Roane county, and a pure white variety from western Blount county. This mineral may be distinguished by its weight.

Sulphate of Lime, or Gypsum, is one of those minerals whose importance causes it to be sought after both in Agriculture and the Arts. In our own State we only find it crystallized in limestone rock; but being contiguous to the plaster-basin or salt region of Virginia, it is readily obtained from thence for agricultural purposes. It has been supposed that the salt series of rocks extended into our own State; but, though numerous borings have been made, as yet nothing has been obtained to compensate for the labor bestowed.—Several of our strata, especially those ranging from Anderson county to Virginia, belong to that series of rock which in New York embraces the Saline Springs, as at Salina, N. Y.

The plaster is most generally found in basins, of which the great Paris basin is a noted instance. Between Abingdon and the Tennessee line, the Va. and E. T. Railroad passes through such a basin, and its importance on the completion of that road is incalculable.

Salt.—Many attempts have been made to obtain salt at various localities. This has been attempted by means of borings to considerable depth; and though the waters, which have come to the surface through them, have been of a saline character, yet so far of insufficient strength to reward for the labor bestowed. In 1838 we visited a boring which was being made some ten miles south of Kingsport, and though salt-water was reached, yet no benefit was derived from it.

The most extensive operations yet carried on in East Tennessee were performed by the late Joseph Estabrook, whose untiring and confident expectations, based as they were upon his scientific explorations, gave hope of success. But just as he was ready to begin the evaporation of the water, he departed this life. He was for years engaged in sinking his augurs, and after passing through successive strata of sandstones, shales, limestones, and even coal itself, he reached, at a depth of some 8 or 900 feet, a stream of salt-water, which he pronounced good. Since his death the works have been suspended. At the point where he sank his augurs, occurs an extensive *fault* or fracture of the stratum, such as we have alluded to as entering into the geological construction of the entire eastern portion of the State.

Carbonate of Lime.—The limestone rocks are properly an impure Carbonate of Lime. They constitute the greatest proportion of the rock strata, and differ in purity in different regions. Like the coals, the nearer they are to the granite rocks, the purer are they. Thus we descend in the degree of purity from the primitive limestone, of which the *Parian* marble may be taken as a representative, to the calcareous deposits of the later geological periods. The marbles belong to the limestone series, and differ according to their degree of purity. The white granular limestone, sometimes called *statuary marble*, belongs to the primary rocks. Beginning at Talladega, Ala., a stratum of the primitive limestone may be traced in a north-eastern direction to Rome, Georgia, thence to Ellijoy, thence to Murphy, N. C., and thence to the Tennessee River, where the Nantagalee River empties into it. At Murphy there are three strata of different colors—bluish white, reddish white, and white—possessing all together a thickness of nearly 60 feet.

Throughout East Tennessee the limestone strata belong to the Lower Silurian formation, and are uplifted at an angle of 45 degrees—the inclination being to the south-east. All of these strata, as well as all other rock strata in East Tennessee, may be traced in a N. E. and S. W. direction, except at points where some disturbing force has broken up and contorted them.

These limestone strata present several series, to which reference has been made in the Geological Sketch.

Among these series are found several of *marble* of various colors, from reddish white to black.

These marbles may be classed according to their geological position, or their internal characters:

1. The Breccia Marble of the Unaka Range.
2. The Black Marble.
3. The Magnesian Limestone Marble.
4. The Whitish Variegated Marble.
5. The Reddish Variegated.

We might have placed first in this classification the snow-white marble of the *eastern* declivity of the Unaka mountains, but prefer confining our remarks to those in our own State. We have consequently made our classification according to geological position, and defined each by its physical characters.

So uniformly do the rock strata preserve a N. E. and S. W. direction that it is easy to trace out one of these strata of marble almost through the entire length of East Tennessee. Thus the stratum which is to the North of Knoxville is on a line continuous with that north of Rogersville.

1. *Breccia Marble.*—Dr. Troost in his third report announced the fact that "some parts of East Tennessee contain beautiful varieties of calcareous breccia," and in his fourth reiterated the fact, "I have seen there (East Tennessee) breccia marble which surpasses any that I know." He directed attention to no specified locality. During my researches through East Tennessee, I have examined several strata of these Breccian limestones in the counties of Blount, Monroe, Sevier and Cocke. The strata are all along the western declivity of the Unaka mountains, and observe the same general direction and dip as the strata of East Tennessee, and being thus situated, the extent of it from Georgia to Virginia may be readily and safely conjectured. Its thickness may be estimated at seven hundred feet. A specimen before me from the West Fork of little Pigeon River, Sevier county, is of fine quality and dark colors. Its angular fragments are cemented together by fine whitish veins. Another specimen from Citico creek, Monroe county, is composed of angular fragments of limestone of several shades of black and gray, with white veinings. As the lines which define the various fragments are perfectly distinct, the veins are seen to cross from the one to the other without interruption. The stratum is quite thick. It readily admits of a fine polish.

Another marble from the vicinity of Cleveland possesses such a resemblance to the foregoing, a black ground, with numerous white veins, that it may be regarded as a continuation or spur of the foregoing.

2. *Black Marble.*—In connection with the foregoing stratum is a stratum of uniform *Black Marble*. The texture is firm, grain fine, and it admits of a smooth and shining polish. At Dandridge this stratum of black marble is quite thick, and much used.

It is easily quarried, and being on the head waters of the French Broad may be readily shipped to market.

3. *The Magnesian Limestone Marble* constitutes, as we remarked in our geological sketch, the lowest stratum in the valley of East Tennessee. It composes the stratum which forms the anticlinal axis of Powel's Valley, and is found as one of the members of the many series which go to make up the rock strata of East Tennessee. It is of a grayish white color, very compact, and though not susceptible of as fine a polish as other varieties, yet will make a fine building stone. It is this stratum which lies underneath the city of Knoxville, extending from the river to the vicinity of the depots, being about 2000 feet thick.

Whilst in the limestones of Middle Tennessee are found numerous beautiful crystals of magnesian carbonate of lime, in East Tennessee many of the entire strata of rock are composed of this magnesian carbonate. The reddish colored veins which are found so constantly intersecting the blue limestones, the variegated marbles, and the red argillaceous limestone, is the magnesian carbonate of lime. It occurs in large strata throughout East Tennessee. It is very hard and difficult of being burned into quicklime. It has been believed that the existence of magnesia in the limestone of any district, is an indication of sterility, magnesia being supposed to be hurtful to vegetation. Facts, however, do not support the belief.

There is a stratum of chert limestone interstratified with the magnesian limestone of East Tennessee, which presents some striking characteristics.

1. It presents the appearance of a vein thrown out between the layers of limestone, imparting its character to the contiguous rocks, and infiltrating itself into its fissures and seams. The city of Knoxville is built upon this magnesian limestone, and these chert veins are found at Stony Point, near the mouth of 2d creek—the Rabun Gap Road being cut through it—also near the mouth of 1st creek. Another stratum is found on the bluff overlooking Flag pond, through which Gay street is cut. Its presence may be supposed wherever the surface of the ground is covered over with fragments of flint rock.

Some specimens from the vicinity of Knoxville present the appearance of modules of chert cemented together with calcareous matter. The chert nodules were evidently hollow, as the calcareous cement apparently fills up the cavity. Though hard, and the component parts possessing different density, yet it may admit of a polish.

4. *Whitish Variegated Marble.*—This variety, and the succeeding might properly be classed as one, as they lie contiguous to each other. This is the stratum which composes the bluff at Mecklenburgh, the residence of Dr. J. G. M. Ramsey, and also that near the residence of Col. John Williams, 2 miles east of

Knoxville. It is white, with numerous red specks interspersed through it. It is used for tombstones and slabs, and is extensively worked in Knoxville.

The same stratum is found on the south side of the river, and of course might be discovered to the N. E. or S. W. of these points. We have traced it through New Market Valley.

5. *The Reddish Variegated Marble* is the most abundant, and that which has been most extensively quarried in East Tennessee. It is of various shades of red and white, with greenish specks, and being composed, in a great degree, of crinoideal fossils, it presents a beautiful appearance when polished. The stars and the stems of the encrinites are quite distinct. Some specimens are quite uniformly red, others red and white in a heterogeneous mixture; others again are red and white in wavy lines, whilst others are reddish with white crystalline veins, anastomosing like net-work throughout the entire mass. These strata are thick and easily quarried.

The Rogersville marbles were those which were first opened. As early as 1838, in company with Dr. Troost, we examined this quarry, and information given as to its extent and value. The specimens obtained at that time, polished for and presented to us by Dr. Walker, of that place, though handled by hundreds, yet preserve their original polish. We do not know the extent to which these quarries have been opened, nor yet what success the companies met with. They have now a better outlet by Railroad than they ever possessed, and it is believed that the works will be continued more successfully. The blocks for the National Monument, at Washington, came from these quarries. Some are composed of innumerable small white and red grains, with an occasional greenish speck of chlorite, while others are deep red, intersected with veins of white magnesian carbonate of lime. In these quarries there are various shades of red, some are almost pure white.

Mr. Sloan's quarry, two miles east of Knoxville, is probably on the same stratum as the Rogersville quarry. The marbles are of the same character. They are much used in Knoxville, and from this quarry was obtained the columns for the chambers of the Capitol.

Mr. Sloan, under charter from the Tennessee Legislature, is now organizing a company for the more productive working of these quarries. He has a contract to furnish marble for the interior decorations of the Ohio State Capitol.

Dr. Grant's quarry, 22 miles from Knoxville, on the line of the Railroad, is a continuation of the same stratum, and many specimens have been obtained, filled with fossils, variegated, of an impure reddish white, and black with white veins.

Dickeson's quarry, near Knoxville, is on the same stratum,

and work will soon be begun for the manufacture of mantels, slabs, tombstones and monuments.

In this quarry slabs possessing a yellowish cast have been obtained; also a variety which, for the regularity of its stripes or bands of white and red, Dr. D. denominates the zebra marble, or, as fossil encrinal stems are found in it also and resemble stars, a more suitable name would be the *banner* marble.

There is another and different stratum of marble one mile south of Knoxville, on the Maryville road. This stratum is about 300 feet thick. A lease has been taken on the property by Prof. M. W. Dickeson, of Philadelphia. It differs in no respect from the foregoing quarries.

There is also a stratum of these variegated marbles at New Philadelphia, a continuation of the last mentioned.

Another stratum is to be found north of Clinch mountain, and may be traced through the entire length of that valley.

There is a blue compact limestone, interspersed with white spots, the internal cast of a fossil shell, found in Hamilton county, on the line of the Nashville and Chattanooga Railroad. It will make a beautiful marble.

There is also to be found on the line of the Nashville and Chattanooga Railroad, not far from Lookout Depot, a stratum of reddish variegated marble—a specimen of which we have had polished, and proves to be of good, we may say excellent, quality. The strata examined presented a darker shade of red than is to be found in the generality of our East Tennessee marbles.

The building stone found in Chattanooga, when dressed will present a fine appearance, but being largely mixed with earthy matter, it will not admit of a fine polish. One of the specimens is of a soft yellowish color, intersected with reddish veins of carbonate of lime. The quarry is a fine one, and supplies the city.

Similar to the foregoing, though containing in addition a large per cent. of silicious matter, is a stratum of limestone from the lands of Col. D. P. Armstrong, near Knoxville. This is the same stratum which has been opened on the lands of Mr. Moffett, below the city, and which has supplied the stone for the building of the pillars on the Rabun Gap road.

In the same quarry is a more compact stratum which affords a smooth conchoidal fracture, and the reddish seams, through a grayish white ground, present a beautiful appearance in the polished specimen. Its compactness requires it to be worked with care.

ART V.—ON THE GEOLOGY AND PHYSICAL GEOGRAPHY OF NORTH AMERICA.* By Prof. HENRY D. ROGERS, from the United States.

(Continued from page 424, Vol. VIII.)

American Coal Fields.—The speaker selected from the many topics presented by this sketch of the geology of North America, that of the coal fields of the United States and British Provinces, as presenting a theme of general interest, describing first briefly the carboniferous formations, especially their coal measures.

This formation consists, in the United States and North-eastern British provinces, of argillaceous and silicious sandstones, conglomerates, clay shales, fire clays, and coal slates; argillaceous limestones, chiefly of marine origin, and seams of coal. A coarse silicious conglomerate or mill-stone grit, generally destitute of coal, underlies the productive coal measures throughout nearly all the different basins, proving the universality of the action which attended the commencement of that state of the physical geography that witnessed the production of the coal seams and the sediments which enclose them.

The eastern half of the continent exhibits five great coal fields, extending from Newfoundland to Arkansas. 1. The first, or most eastern, is that of the British Provinces, Newfoundland, Nova Scotia, Cape Breton, Prince Edward's Island, and New Brunswick. This seems to have been originally one wide coal field, subsequently broken up into patches by upheaval and denudation, and by the submergence which formed the Gulf of St. Lawrence: the area of the coal measures of the provinces is probably about 9000 square miles, though only one-tenth of this surface appears to be underlaid by productive coal seams. 2. The second, or great Appalachian coal-field, extends from North-eastern Pennsylvania to near Tuscaloosa, in the interior of Alabama. It is about 875 miles long, and 180 broad, where widest in Pennsylvania and Ohio, and by a careful estimate contains about 70,000 square miles. The narrow basins of anthracite in eastern Pennsylvania, containing less than 300 square miles of coal, are outlying troughs from this great coal field. 3. A third, smaller coal field, occupies the centre of the State of Michigan, equidistant from Lake Huron and Michigan; it covers an area of about 15,000 square miles, but it is very poor in coal. 4. A fourth great coal field is that situated between the Ohio and Mississippi anticlinals, in the States of Kentucky, Indiana, and Illinois. It has the form of a wide elliptical basin. It is about 370 miles long and 200 miles wide, and contains by estimation 50,000 square miles of coal measures. 5. The fifth, and most western

* Notices of the Meetings of the Royal Institution of Great Britain, Feb. 8th, 1856.

is the large and very long coal field, filling the centre of the great basin of carboniferous rocks which spreads from the Mississippi and Ozark anticlinals, westward to the limit of the palæozoic region, where the cretaceous strata begin. The coal field itself has its northern limit on the Iowa River, and its southern near the Red River on the western border of Arkansas. It is in length 650 miles, and in greatest breadth 200 miles. The total area of this great irregular basin is probably not less than 57,000 square miles. Three or more small detached tracts of coal strata, encompassed by the cretaceous deposits, stretch at intervals south-westward from the southern limit of the longer field through Texas. They are probably extensions of the great field laid bare by denudation. Other localities of coal-bearing strata occur in the high table lands on both sides of the Rocky Mountains, and also in the Wahsatch chain of Utah, but it is doubtful whether any of them belong to the true carboniferous series. The aggregate space underlaid by these vast fields of coal amounts to at least 200,000 square miles, or to more than twenty times the area which includes all the known coal deposits of Europe, or indeed of the whole eastern continent.

These coal fields, especially the four lying west of the Atlantic slope, exhibit several interesting facts of gradation, which render it highly probable that they were, at one time, all of them connected, the vacant intervals now separating them having been denuded of their coal measures by the wide-sweeping erosive action of the waters of the Appalachian Sea, set in motion by the uprising of this part of the continent. The first fact of such gradation relates to the thickness of the formation, and that of the individual coal seams in the respective coal fields, the comparison indicating a marked reduction in this respect from east to west. Thus the productive coal measures of Nova Scotia have a thickness of nearly 3,000 feet, those of the anthracite basins of Pennsylvania a depth about as great, while those in the central parts of the great Appalachian basin show a thickness not exceeding 2,500 feet. Again, in the Illinois basin the probable thickness is reduced to 1500 feet, while in the farthest, or Ohio and Missouri basin, it cannot exceed 1000 feet. Very similar is the reduction in the number of the coal seams. Those at the Joggins, in Nova Scotia are about 50; though only five of them are of workable dimensions, being equivalent to about 20 feet of coal. The deepest anthracite basin of Pennsylvania, that of the Scuylkill, contains also about 50 coal seams, but 25 of these have a thickness each of more than three feet, and are available for mining. Further west, the great Appalachian coal field contains about 20 beds in all, 10 of which are thick enough to be mined. Still further onward, the broad basin of Indiana and Illinois shows apparently not more than 10 or 12 beds, and it is believed that only seven of these are quick enough and pure enough for min-

ing. Northward in the Michigan coal field, denudation has left only two or three lower beds. Still further westward, the coal field of Iowa and Missouri contains, it is believed, but 3 or 4 beds of profitable size, and the total number, thick and thin, does not exceed 6 or 7. A similar gradation is noticeable in the general size of the individual coal seams, by far the thickest being in the anthracite basins of eastern Pennsylvania.

Parallel with this progressive reduction in the amount of land-derived material in the upper coal formation, is a diminution in the coarseness of the mechanical ingredients of the strata, the eastern coal measures having more conglomerates and coarse sandstones, the western more fine-grained argillaceous sandstones and clay beds; and as a further indication that the first land lay to the east and the ocean to the west of the wide coal-producing plains or meadows, there is with this westward reduction of the mechanically-derived sediments from the land, a steady augmentation of marine limestones, and other true aqueous deposits, precipitates of a shallow carboniferous sea. In some of the more western coal fields the alternation of the terrestrial coal seams with super-imposed limestones, containing marine fossils, amounts even to an occasional actual contact of the two kinds of strata.

Apart from these general phenomena of gradation which belong to the conditions under which the strata originated, there exist other facts of transition, which also imply a declension westward, of quite another class of forces than the productive ones. In the Appalachian chain, all the eastern coal basins, and the eastern margin of the great Appalachian field, give evidence of a crust metamorphism, affecting all the palæozoic rocks, the degree of alteration dependent on the nature of the stratum, and its situation, eastward or westward, in this great undulated zone. The coal, of all rocks the most sensitive to metamorphism from heat, presents invariably among the eastern flexures of the Appalachians, where the crust action has been greatest, the condition of a hard and flinty anthracite with a jaspery or large conchoidal fracture; further westward in the same set of basins, the anthracite has a more cuboidal fracture, is softer, and is even slightly gaseous. Entering the eastern border of the great Appalachian bituminous coal field, we every where find the coal possessed of only half its full share of volatile or gaseous matter; and it is not until we reach the middle and western side of this wide basin, that the coal is found fully bituminous,—in other words not until we pass beyond the last of the perceptible undulations of the crust. Throughout all the flat fields of the Western States, the coal invariably retains its original full amount of bituminous or gaseous ingredients.

Comparing the areas of the coal fields of other countries with those of North America now indicated, Great Britain may be estimated to contain about 5400 square miles, France 1000, and

Belgium 510 square miles. Rhenish Prussia—Saarbrook field—has 960 square miles, Westphalia 380, the Bohemian field about 400; that of Saxony, only 30; that of the Asturias, in Spain, probably 200; and that of Russia scarcely 100 square miles. And as these are the principal known coal fields in Europe, the whole is thus seen to possess less than 9000 square miles of productive coal measures. Comparing the coal areas with the total areas of the respective countries, the United States has one square mile of coal field to each 15 square miles of its 3,000,000 miles of territory; Great Britain has one square mile to each 22½ of surface; Belgium a like proportion; while France possesses only one square mile of coal field to every 200 miles of country. Assuming the total area of the productive coal measures of the world at 220,000 square miles, and accepting 20 feet as the average thickness of the available coal, the entire quantity, if estimated as one lump, is equivalent to a cube of very nearly 10 miles' dimensions, or equivalent to a cake or plateau of coal 100 miles square in its base, and 440 feet high.

The present annual product of the chief coal-producing countries is as follows:—Great Britain extracted from her coal mines last year—1855—the enormous quantity of 65,000,000 tons; the United States between 8 and 9,000,000; Belgium, about 5,000,000; and France, 4,500,000.

It is interesting to compare the dynamic force of coal applied as fuel to the generation of steam in the steam engine, with the dynamic effect of a man. The human laborer, exerting his strength upon a treadmill, can raise his own weight, say 150 lbs., through a height of 10,000 feet per day, equivalent to 1 lb. raised 1,500,000 ft. The mechanical virtue of fuel is best estimated by ascertaining the number of pounds which a given quantity, say one bushel, will raise to a given height, say one foot, against gravity. In the steam engine this is called the *duty of the fuel.* Now, the present maximum duty of one bushel of good coal in the improved Cornish steam engines, is equivalent to 100,000,000 lbs. lifted through one foot; but one bushel has been made to raise 125,000,000 lbs. one foot high, or one pound 125,000,000 of feet; but as there are 84 lbs. in one bushel, this divisor gives one pound as equal to 1,500,000 ft.; just the result of a man's toil for one day upon a treadmill. Thus a pound of coal is really worth a day's wages. If we estimate a lifetime of hard work at 20 years, giving to each year 300 working days, we have for a man's total dynamic effort 6000 days. In coal this is represented by the amazingly small amount of *three tons.* Another proof of the extraordinary power derivable through the combustion of fuel is presented in the following calculation; one cubic inch of water is convertible into steam, of one atmospheric pressure, by 15⅛ grains of coal, and this expansion of the water into steam is capable of raising a weight of one ton the height of a foot. The one

cubic inch of water becomes very nearly one cubic foot of steam or 1728 cubic inches. When a vacuum is produced by the condensation of this steam, a piston of one square inch surface, that may have been lifted 1728 inches, or 144 feet, will fall with a velocity of a heavy body rushing by gravity through one-half of the height of the homogeneous atmosphere, or through 13,500 feet. This gives a terminal velocity of 1300 feet per second, greater than that of the transmission of sound. From this we can form some estimate of the strength of the tempest which alternately blows the piston in its cylinder, when elastic steam of high pressure is employed. Applying the calculations of the dynamic efficiency of coal, for estimating the mechanical strength latent in the coal fields of the earth, or in the large coal product annually furnished by the mines of Great Britain, we get some interesting results. Each acre of a coal seam, four feet in thickness, and yielding one yard net of pure fuel, is equivalent to about 5,000 tons; and possesses, therefore, a reserve of mechanical strength in its fuel, equal to the life-labor of more than 1600 men. Each square mile of one such single coal bed contains 3,000,000 tons of fuel; equivalent to 1,000,000 of men laboring through 20 years of their ripe strength. Assuming, for calculation, that 10,000,000 of tons, out of the present annual product of the British coal mines, namely 65,000,000, are applied to the production of mechanical power, then England annually summons to her aid an army of 3,300,000 fresh men, pledged to exert their fullest strength through 20 years. Her actual annual expenditure of power, then, is represented by 66,000,000 of able-bodied laborers. The latent strength resident in the whole coal product of the kingdom may, by the same process, be calculated at more than 400,000,000 of strong men, or more than double the number of the adult males now upon the globe.

Climates.—Adverting to the causes of the characteristic features of the North American climates, those of all the eastern and northern divisions of the continent were shown to depend primarily upon the peculiar distribution of the land and water, and the general circulation of the winds and oceanic currents in the North Atlantic and the Polar basins, resulting from general phenomena of rotation of the fluids, and from the configuration of those seas. The chief surface currents of both these basins, belong all to one great circulating stream, which crossing the Atlantic from Africa to the Gulf of Mexico, under the northern tropic, and following for a vast distance the highly-heated shores of South and Central America, enters the North Atlantic at Florida, under the name of the Gulf Stream, carrying a temperature of 5° to 6° higher than the mean heat of the equator, and imparting to the southern coast of the United States the ocean temperature of the tropics. Pursuing its career to the north-east, this current transports its own mild climate to the whole north-western

side of Europe, and even suddues the rigors of the European Polar Sea; but refrigerated, as it sweeps around, in its circumpolar course, the shores of Siberia and Western Arctic America; and, loaded with the annual ice of all that extended zone, it streams through the great Archipelago of North-eastern Arctic America, clogs its deep channels with its floating packs of ice, and chills to the zero temperature of the whole hemisphere this coldest of all the summer climates of the globe. Returning into the Atlantic around Greenland, and by its main passage through Baffin's Bay, this now Arctic ice-chilled and ice-transporting current hugs the whole north-eastern coast of the continent inside of the Gulf Stream. It thus weaves a track somewhat resembling the figure 8. The Gulf Stream on the south-east, and the Arctic current on the north, conjointly with the tropical and the polar winds with which they are connected, produce such a contrast in the temperature of the southern and northern latitudes of eastern America, that all the zones of the climates of the sphere are there compressed within not more than 30° of a great circle, crossing the continent from the Gulf Stream to lat. 70° north of Hudson Bay.

The climatology of the western half of the continent was next discussed. There the controlling agent in the latitudes north of the north-east Trade Wind of the tropic, is the south-west and west wind from the Pacific Ocean, and in the Southern Atlantic States from the Gulf of Mexico. This Pacific Ocean wind, moderately charged with moisture in the lower latitudes, and excessively humid in the more northern ones from traversing a wider tract of sea, confers a temperate, moist, and oceanic climate upon the Pacific slope; but deprived largely of its moisture by ascending the high mountain barrier of the Pacific chain, which robs it of nearly the whole of its wetness, it exerts in the more southern latitudes, just the opposite effect upon the plains and table lands to the leeward or eastward of that barrier. The high evaporative power of the winds thus parched accounts for the excessive aridity of the Colorado and Utah deserts, and the whole desert belt of the interior, which in the lower latitudes stretches to Texas. It likewise explains the prevalence of numerous salt lakes destitute of outlets, and the occurrence of the wide tracts covered with salt, or with a saline soil, within this area.

Gold.—To the same general cause, the Pacific wind, we are to attribute the abundant gold alluvia of the western slope and base of the Sierra Nevada. The copious precipitation of rain, amounting to nearly the whole humidity of the Pacific wind, against the gold-containing western flank of the Californian chain, greater probably in the pleistocene than in the modern epochs, has produced an enormous erosion of the gold-bearing and cleavage fissured rocks; and has strewn and sorted their fragments and particles in the ravines of the mountain, and in the plains at its base. The speaker concluded with an announce-

ment of the general fact that, whereas the salt fields of the earth are found upon the continental or interior dry sides of its oceanic chains, its gold fields are restricted to their wet or oceanic slopes.

(To be continued.)

Art. IV.—DESCRIPTION OF THE COMPRESSED AIR ENGINE AT GOVAN COLLIERY.* By W. C. Randolph.

[Read before the Institution of Mechanical Engineers, Glasgow.]

This engine was designed for a special purpose in the working of the Govan Colliery, near Glasgow, where an ordinary engine was not applicable; and although under other circumstances not an economical mode of employing power, it has proved in the present case highly satisfactory, and has worked successfully for several years.

The main shaft is sunk 176 yards deep, through six successive seams of coal, the first of which is 92 yards from the surface at that point; and after working the coal at that part, a main road was driven horizontally to a distance of 706 yards, intersecting the coal seams, which dip at an inclination of about 1 in 11. A second shaft, at present 26 yards deep, was then sunk near the extremity of the main road, for the purpose of working the third seam, or "rough main" coal. The difficulty then arose of providing for the winding and pumping of this second shaft at a distance of nearly half a mile from the first shaft. A steam boiler was inadmissible in that situation, and the distance was too great to convey steam from the surface. Some application of water power was contemplated by the manager, Mr. James Allan, who applied to the author for the purpose of carrying it out; and it was then proposed by the author, upon the original idea suggested by Mr. David Elder, to make use of compressed air, supplied by a compressing steam engine at the surface, and conveyed down by a pipe, to work an engine at the top of the second shaft, in the manner of a non-condensing steam engine, the discharged air being thrown into the workings to aid in the ventilation of the mine. This proposal was adopted, and the present engine was designed and constructed for the purpose, by Messrs. Randolph, Elliott & Co.; it has now been working at the colliery more than six years, and has been found to answer the purpose completely.

The main shaft contains a single winding apparatus and a set of four pumps, and forms the downcast shaft for the ventilation; it is 18 feet long and 8 feet wide, being oval at the top and rec-

* From the Lond. Mech. Mag., Feb., 1857.

tangular below. It opens at the bottom to the horizontal main road, which is 9 feet wide and 6 feet high, divided by a brattice in the centre throughout the whole length, for the downcast and upcast currents. The upcast shaft, 7 feet diameter, has a ventilating furnace at the bottom, and contains a single winding apparatus. In a recess at the top of the second shaft, is fixed the air engine for working the winding and pumping apparatus of the second shaft. The compressed air is conveyed to it by a cast iron pipe, 10 inches diameter inside, carried down the main shaft, from a steam engine at the surface, which is employed to compress the air.

The steam cylinder is 15 inches diameter, with a stroke of 3 feet, and drives two condensing air pumps, which work alternately one on each side of the beam centre, delivering the air into the centre reservoir, from which it passes into the main pipe. The beam is connected at the other end to a crank and fly-wheel, to equalize the motion. The air pumps are 21 inches diameter, with a stroke of 18 inches; they are placed inverted, with the piston rods passing out below, where the stuffing boxes are not exposed to the pressure of the compressed air, and are worked with crossheads sliding in vertical guides by means of side rods from the beam. The air pumps are fitted with ball-valves, of which there are three sets to each pump, each set consisting of 44 brass balls, 2 inches diameter, arranged in three concentric rings. The balls are confined by separate cages to a lift of half an inch. In consequence of the high pressure of the air, amounting to 30 lbs. per square inch, provision is made for preventing leakage through the valves, by a stratum of water constantly covering the piston valves and the delivery and inlet valves, through which all the air has to pass. A small pump, 3 inches diameter and 10 inches stroke, is employed to supply water for this purpose, and delivers it into the centre reservoir, from which it flows through the small pipes, into each of the air pumps, during the period of their downward strokes, the quantity of water admitted being regulated by a cock in each pipe. The surplus water is discharged at each upward stroke through the delivery valves, and flows over the top into the centre reservoir, keeping the delivery valves also covered with water; in this way the compressed air is entirely discharged, and there is no loss of power from expansion of air behind the piston at the beginning of the downward stroke. The level of water in the centre reservoir is regulated by means of a gauge glass at the side. Any leakage of water past the piston valves and piston, escapes through the suction or inlet valves, and is carried off by a waste pipe fitted to the casing of the air pumps.

The air pump barrels are lined with brass to prevent corrosion, and the pistons are faced with brass and without packing, being merely turned a good fit to the cylinders. The pumps have con-

tinued working the whole time since starting, a period of more than six years, working part of the time day and night, without requiring any repairs or adjustment; nothing has been done to them, except replacing some of the valve cages which had been broken.

The usual speed of this engine is about 25 revolutions per minute, with a pressure of steam of 18 lbs. per square inch, giving a pressure of air averaging about 20 lbs. per square inch.

The air engine at the lower shaft has a cylinder 10 inches diameter and 18 inches stroke, and works usually at about 25 revolutions per minute; it is an old steam engine, and was formerly worked with high pressure steam. It was intended to be worked with air at 30 lbs. per square inch pressure, and at that pressure the heat generated in compression was expected to be very great; indeed, calculations at the time gave nearly the melting point of tin. The great safety valve, however, for getting rid of the heat developed, is, as was anticipated, the water upon the valves of the compressing engine, which absorbs the heat as soon as generated, a portion of the water passing off through the main pipe in the form of steam; this steam becomes condensed in the pipe, and provision is made for drawing off the water of condensation from time to time as it accumulates at the bottom of the shaft, by means of a cock.

The pressure of the air at the lower engine, is only about 1 lb. per square inch below the pressure of the compressing engine at the top of the pit. The absorption of heat on the sudden liberation of the compressed air from the lower engine, at the discharge of each stroke, causes so great a degree of cold, that in winter the engine is often stopped by the formation of ice in the cylinder and exhaust pipe.

Art VI.—VENTILATION OF MINES.

In a lecture recently read before the government school of mines, England, on this subject, we find the following account of the systems of ventilation now practised in that country. In some places it is effected by a triangle being placed over the mouth of the shaft, from which the fire is suspended in a vessel by chains; it was notad visable to place it at the bottom, but at some slight distance from it. Different sorts of furnaces were at times used, the air passing through the furnace-bars; sometimes the furnace-drift is obliged to be of some length—from eight to ten or twenty yards; the furnaces were of various constructions, and a representation of a double furnace was described. This furnace gene-

rally had an arch of brick, and it was so placed as to avoid setting fire to the bed of coal in its vicinity. Sometimes an arch was built at the side, in order that a current of air might be allowed to pass through it, as well as to isolate the furnace; at other times an opening was left, and this was filled with stoppings, or some other non-combustible material; the width of the furnace was in general from 5 ft. to 11 ft., but there was a great difference among colliery viewers, as to the height of the furnace-bars. It required that when the furnace was fed the coals should be thrown dexterously in, so that they might be uniformly cast over the whole surface. It was necessary that there should be kept up a constant current of air with very little smoke. Sometimes the draught was augmented by putting up what was called a "blower."

In some parts of Belgium the Government will not allow the collieries to be ventilated with furnaces, in order to prevent accidents from the return air. The furnace is especially difficult and dangerous to deal with when an accident has recently taken place; and it is a most critical task to light a fire after an explosion has occurred. When it is not thought compatible with the safety of the men to send them down, the furnace is lighted by means of an iron wire suspended by a ring. At times, it has been found, under efficient arrangement, to be very efficacious; but it should be properly looked after, and much must depend upon the temperature of the air. In the upcast the temperature varies from 160 deg. to 120 deg.—the average might be computed at 140 deg. The downcast shaft could be reckoned at 60 deg. Here there was a difference of 80 deg. The furnace at the Hetton Colliery passes 200,000 cubic feet of air per minute. The idea which was entertained by some persons, of introducing air-pipes into the air-ways was perfectly futile; the plan had been tried on many occasions and found insufficient. The lecturer next alluded to Mr. Goldsworthy Gurney's plan of introducing a jet of steam at a high pressure. This gentleman thought that if, instead of a furnace, he would put down a pipe, that a jet of steam would produce a sufficient current of air. This plan excited a great deal of notice at the time; a committee of the House of Commons was appointed to consider its merits, and several experiments were carried out at the Polytechnic Institution on a small scale.

A number of practical experiments were made; the steam pipe was taken to the bottom of the pit. This was found, in a comparatively short period, to exhaust the steam of several boilers, and but very little ventilation arose from it. A dozen to thirty-six steam jets were tried—some of them from one-eighth to one-sixteenth of an inch in diameter; the quantity of air was gauged; all these methods were attempted; the steam was let off, the fire lighted, and it was found that the effect given by the furnace was much greater. A great many experiments had been

tried in several parts of England, where the steam jet had been found extremely useful as an adjunct. The point, however, to be considered in the working of coal mines was the laying out of the collieries in the first instance, so that the air could be distributed over those parts where the men were engaged.

The fuel used in the furnace was generally small coal. The general consumption of an ordinary furnace was about two tons in 24 hours. In order to make the furnace more secure from return or vitiated air, you may keep it without. This may be effected by bringing from some other part of the workings a stream of air, commonly called a 'scale,' solely to feed the furnace. There was sometimes a great difficulty in carrying this; and when he had occasion to examine the Risca pit, the cross-headings were not free from gas. Splitting the air was a great improvement; this, as well as working in compartments, has been a great benefit to the miner; in some collieries the air was split into as many as 8, 10, and even 16 parts. The mode of ventilating the goaf is always a source of great danger. A strict discipline, however, should be observed. In some places none but safety lamps were allowed to be used, and this regulation should be rigidly enforced, as many accidents might be prevented.

The temperature of the atmospheric air, as he had previously observed, had a considerable effect on the ventilation of a colliery. In many cases a barometer was kept at the surface, and it was always advisable to have one underground, as by it they were enabled to see the quantity of air that was required, and where it was deficient. When a large escape of gas takes place from the oaf, it is always desirable that they should put more air to it, in order that it should be diluted. The distribution of air was a most important subject, and attracted the attention of colliery viewers for a considerable period. The lecturer then alluded to the laws on the subject laid down by Marriotte and Gay-Lussac; a comparison was then drawn between the resistance of air in levels of one mile and nine miles in length, together with the power to overcome it; if in the one case the velocity of the air was 3 feet in a second, and in the other 6 feet, the resistance will vary as the square of the velocity; in the one instance it will be 9, in the other 64. It is always important to reduce the velocity of the air; at the same time it should be of such force as to provide a good current. This was one of the reasons why there had been such an objection against large fans being employed—it was always more preferable that the air should be regulated at a lower velocity than that it should be allowed to course with too great speed. The air-ways ought always to be made of sufficient size. Some colliery viewers were of opinion that they should be of small dimensions. If constructed large, so as to afford a free passage for air, much of the expense of machinery would be avoided. When the air went through a goaf it gener-

ally met a greater resistance at the rough sides. The air-way should be as smooth as possible; where this was left with rough shale it became very prejudicial to the passage of air.

It was an acknowledged fact, that two-thirds of the men whose lives were sacrificed were killed by the choke damp after the explosion had taken place. The laying out of the works in the first instance should be studied. If the upcast were placed at a distance from the downcast, there would always be a current through. Special danger arose from blowers. These are occasionally near faults. Blowers occur in the line where dislocation had taken place. In some cases the only way they had was to knock a blower out with gunpowder; this, however, was dangerous under ground. As to the danger likely to arise from the burning of the coals, and the various modes which were tried to extinguish this: In some cases it was taken out with shovels; in others they were obliged to cover the shafts, and several instances had happened where the fire had lasted for weeks; the wetting of the coal and the pyrites in cases often caused the very accidents that it was desirous to avoid. Mr. Goldsworthy Gurney was of opinion that where conflagration with small coal occurred, it could be extinguished by driving down carbonic acid by means of a steam pipe. This was found efficacious in one instance, but in others had not been so successful; like Mr. Phillips' Fire Annihilator, it sometimes had the power of producing that destructive element—an admixture of carbonic acid with atmospheric air being very likely to have that effect. Sometimes, when a fire could not be put out by ordinary means, a drift was cut around it to isolate it from the other workings; at other times water was let in, either by leaving off pumping, or turning in the course of a small stream, as had occurred in the case of the late fatal accident. Testing the ventilation of mines was very simple—if the level was of a regular size —say 6 feet by 5 feet; you have an area of 30 square yards. By firing a pistol, and following the smoke, with a watch with seconds-hand, the volume of air could be ascertained; others did it with a candle, walking steadily, looking at the flame, and judging from that whether the air was going backwards or forwards.

Art VII.—ON DRESSING OF ORES.

In the lectures recently delivered by Mr. Warrington Smith, before the Government School of Mines, London, the lecturer remarked, that in the preceding lecture (published in June), he had treated of the general separation of the ores by hand-picking; he should now make a few observations on some of the mechani-

cal means that were adopted in the dressing of ores. It would be remembered that at the time of the gold discoveries in California and Australia, there was great speculation afloat, and the public attention was drawn to those countries. At that period there were several inventors who started up and presumed they had the good fortune to elaborate a machine which would possess all the necessary requisites for reducing the ores. In the course of two or three years these innovators started up, not by twos or threes, but by dozens, each assuming that the concoction produced by him was to be perfect, entirely ignoring the fact that there were machines in England which had been in use for centuries, and had gradually received every practical improvement that was necessary. It was very probable that many of these kind-hearted individuals had never been in a mine, and the mischief with these was that the work was not well done, but most inefficiently performed. With some ores it was not necessary that they should be reduced to such a degree of fineness as others. Among the apparatus for that purpose was the arrastre, which was extensively employed in Spanish America: this was a circular pan; in the middle was a spindle; coming from this were four arms, to the end of which were attached large stones. A rotatory motion was communicated by a horse-whim or other means, and by it the ores, in a comparatively short period of time, would be ground down to an impalpable powder. A similar machine to this was used at the Potteries in North Staffordshire district, for the purpose of grinding flint. This was first calcined, the crushing stones were generally of the hard mountain-limestone (chert); water was allowed to enter, and it became reduced to a pulp. These machines were usually erected in some outlying districts, where water-power was attainable—occasionally steam was used where this could not be obtained. Certain materials should not be reduced to an impalpable powder. This was especially the case with several of the metals, as in the ulterior processes a considerable loss ensued. Some machines were used with edge rolls for grinding clays and mortars; the disc has generally an edge of iron, but there is the same objection to this as those previously mentioned, it not being serviceable for metallic minerals. The grinder, as used in the Southern and Western districts, has been found to be the most serviceable; in it there are two rolls of cast-iron, and a great deal depends upon the distance they are apart; the surface is in general smooth. There is a great wear and tear on the rolls. Every one is aware of the inequalities in a piece of cast iron, and sometimes in the rolls there will be found cellular holes, and at other places a flat surface will be preserved. In the north of England, and at Alston Moor, the grinders are generally constructed with three pairs of rolls—the first are generally grooved, and will admit pieces as large as a man's head, below this they are passed off on a slate to a finer pair of rolls; generally under

this is a sieve; the third are commonly called chat-rolls. There was a greater simplicity in the crushers and grinders of Cornwall and Devon than those used in the northern districts. In the latter locality one of these would cost several hundred pounds, while in the West one could be erected for £100 or £200. The ore is first required to be spalled before it is put in the machine, the larger pieces, which will not pass the rollers, being picked out. The rolls are divided into two parts—the core and the shell. In Derbyshire, in some of the poor mines, they used hand-crushers; previously the ores were simply bucked; if the material be hard, he was of opinion that not much work would be effected by a single man with this machine. It was of great importance that the crushers should be constructed of materials of the best quality and the strongest iron. A description was then given illustrated by a diagram of the manner of fixing the rolls, together with the carriage, brasses, and the necessary weights to regulate the pressure. The dimensions of the rolls were in general of from 2 ft. to 30 in. in diameter, and in length not above 1 ft. or 15 in.; notwithstanding these were constructed so strongly, while the machine was in operation a considerable vibration could be felt in the building in which it was erected. The speed with which it revolved required to be regulated, as, if it were too rapid, the mineral would go through before it was sufficiently reduced. The speed of the rolls was generally 30 ft. to 40 ft. per minute; the crusher would grind in one hour as much stuff as many of the newly-invented machines would do in the twenty-four. This was generally passed through a circular griddle; the pieces which did not fall through were taken up again, and went anew through the rolls. A description, illustrated by diagrams and models, was given of the various machinery attached to the grinder; these were not applicable to all kinds of tin ores, as the grains of that mineral were so finely disseminated through the vein-stone that they required the employment of the stamps, and to this he should allude in another lecture. Jigging or washing ores was practised in sieves of different sizes, sometimes 3, 4, 6, 8, or 16 holes to the inch; the boys generally stood over pots of water; the action of the water throws up the stone, and the heavier particles of the mineral fall to the bottom; this is not emptied out at first, but allowed to accumulate until there is a sufficient quantity to be taken out by a scraper. This is called the "bed;" above this is the "ragging," then the "skimpings;" in Derbyshire these two last are denominated "chats" and "smithams." Jigging by hand entails great labor, and is attended with great inconvenience, as the work-people have constantly to be stooping. The stuff that remains in the pit is called "hutch-work." Several modes of jigging by levers were then described, as well as one worked with a water-wheel: this many of the overlookers had great objection to adopt, as, from the noise it

made, it was impossible to discover whether the people were at work or not; many of them thus idled their time away, and left the sieves to take care of themselves. A gentleman well-known in the eastern part of Cornwall, Mr. Thomas Petherick, had invented a machine called the "separator;" these were very efficient, but had not been generally adopted in Cornwall—they were used at the Par Consols and Knockmahon mines, both of which had given large returns and good profits to the adventurers; they had likewise been adopted in some foreign mines. With regard to crushing-machinery, the Cornish was one of the most efficacious, and it must be considered as an instrument of the greatest utility for the grinding of copper and lead ores.

The third lecture on Dressing treated of the "stamps." Mr. Smyth observed that in the operations of dressing these were an important element: they were of various constructions, but the best known was the one in general use in Cornwall. In England, whenever a stamps-head or lifter was broken, it was easy enough to replace it by sending to a foundry, where probably they kept patterns in stock, but the case was different abroad, or in newly-settled countries, like Australia and California, and it was a great desideratum that those who were likely to be practically employed in such localities should know what, in the event of a breakage, they could substitute for them. Delays had constantly occurred from mishaps in these countries, and many of the superintendents had been most fertile in their excuses on that head: the lifters of the stamps were in general made of some hard wood, such as pine—this was employed in Cornwall—however, they sometimes had them of iron. The machinery of the stamps required to be very well arranged; the height of stroke should be considered, and all its modifications. In some cases the heads were of hard wood, but this was very seldom, as they were liable to wear away with great rapidity. The lecturer then described the method by which the stamp-heads were cast. The weight of the head and lifter in general varied from 100 lbs. to 600 lbs.; to give a good stroke in crushing hard stuff, such as tin ore, the iron portion of the head should be about 300 lbs. weight. In South America, where they could obtain hard wood, both lifter and heads were made of the same material, and some of them lasted nearly as long as iron. While on the subject of woods and their hardness he would allude to the weapons used by the South Sea Islanders, which were of an excessively tough nature. In some ores, such as silver, the stamps were used dry, but with the generality water was employed, and this was more especially the case with copper halvans. Great difference of opinion existed amongst dressers as to whether it was preferable to work on an iron plate, or allow the stamps to make their own bed; the latter mode was in general considered the more preferable. The methods of inlet and outlet had likewise formed subjects for discussion. In several

places the stamps were so well arranged that by means of a pass they fed themselves. The outlet ought to be well looked to, and placed under proper and efficient control. They had heard of a number of inventions of stamps for crushing gold; many of them had excited attention, but he had not heard of one which had superseded the invention ordinarily in use. In the reduction of gold, if proper arrangements were made with the stamps, they ought to make large profits, and all should be saved. The ordinary stamps were not applicable for gold, although they had been found very efficacious in crushing tin ores, and especially economical and valuable in stamping copper ores of a low percentage. In the outlet a grating was sometimes employed, at others a copper pan. The stroke of the head required to be regulated so that the metal might not be stamped to that degree which is technically termed "dead;" sometimes when this occurred the mineral would be reduced to such a fine powder that it would float on the surface of the water. Stamping over the flash, and several other methods practised in Hungary and Germany, were then described and illustrated by diagrams. There was always a great friction of the lifts on the frame, and this required to be constructed of strong and durable materials. Diagrams were shown of the stamps barrel; in new countries there would often be found a difficulty in getting this. Sometimes the trunk of a tree had been used, and where there was not proper machinery the workmen had endeavored to shape it as near the form of a true cylinder as possible; and several of these substitutes for a well-constructed stamps, although they had not been found to do the labor as efficiently as was desirable, had, nevertheless, got through a tolerable quantity of work. The gratings that were employed for the outlet were of different sizes; the model which was before them would give a correct idea of the stamps in general use, but time and practice only could teach them the various modifications to be used in the different varieties of ore which came under treatment.

ART. VIII.—VISIT TO THE LAKE SUPERIOR REGION IN 1854.

By L. E. RIVOT, Professor French School of Mines.

CHAPTER III.

ON THE DEPOSITS OF COPPER AND SILVER.

IN the preceding chapter I have explained the geological constitution of the country, without speaking of the veins and ores of copper, and of copper and native silver, which are evidently posterior to the formation of the series of trap conglomerates and sandstone. This posterior age is proved by the composition it-

self of the series, and by the disposition of the deposits. The copper and silver are every where found in veins which run parallel to the beds of trap, or cut at almost a right angle all the series.

Apart from the veins we do not find any trace of copper in the sandstones and conglomerates; and if in certain amygdaloid zones of the trap we have established the existence of the copper, the presence of this metal is easily explained by the porous nature of the rock and by the immediate contact of the veins.

It follows that the deposits of copper and silver are posterior to the trap conglomerates and sandstones.

We should then admit that the veins have been produced posterior to the sedimentary series of the lower silurian epoch. The arrangement (disposition) of all the deposits explored to the present time in the American portion of Lake Superior agrees perfectly with this conclusion; it leads to the hypothesis that the veins have been produced by the subsequent filling up of the fissures which the upheaval has caused in all the series.

I shall not give any attention to the deposits in the Island of Michipocoten and on the Canadian shore; their importance has not yet been established, and I have not been able to procure, respecting them, positive information.

At Isle Royale, Point Kewenaw Portage, and in the Ontonagon region, the native copper and ores of copper appear in very different deposits, all of which, however, belong to the same mode of formation and to the same epoch.

We can distinguish, 1*st*. Veins almost vertical—sensibly perpendicular to the direction of the beds of trap and conglomerates, traversing almost without deviation these two series and even the sandstone.

2*d*. Veins parallel to the beds of trap both in direction and inclination, or in direction alone. The first are true veins of contact interwoven between beds of different nature; the second are real veins almost always accompanying important seams penetrating between the beds of the enclosing rocks. They have not as yet been explored except in the trap; they have not been searched for in the conglomerate, because it is known that this series is not metalliferous, and, besides, it is mostly covered by the alluvium.

3*d*. The beds of amygdaloid which are very porous and impregnated with native copper, the richness of which does not seem remarkable except in the neighborhood of the transverse veins, or those parallel to the direction of the series.

Each region has its own peculiar character of deposit. Isle Royale and Point Kewenaw possess principally transverse veins; in the Ontonagon region they have worked, exclusively, the veins parallel to the direction of the beds of trap; in the intermediate region of the Portage they have recognized only feeble veins of

contact, to which the amygdaloid beds impregnated with native copper are attached.

This simple outline is sufficient to show the intimate relation which exists between the mode of deposit and the kind of fractures that the upheaval has produced in the series.

At Isle Royale the transverse fractures are in general less distinct, the veins are less powerful, and have been thus far less productive.

At Point Kewenaw the beds of trap present very close vertical fissures, all normal to the direction; they are numerous at the indistinct bend towards the east, and much more still at the strong inflection which the series takes around Eagle River. In this quarter the upheaval has also produced a push towards the north-west, pressing the beds against each other; they have yielded to the effort, breaking transversely, and the longest fissures have been filled with the substance of the veins, which has been able to penetrate a certain distance in the porous portions of the amygdaloid rocks.

In the Ontonagon region the series upheaved and sustained towards the south and east has undergone at the same time a compressing action of the Porcupine Mountains, which has compelled it to open in two directions, the one transverse, the other longitudinal toward the interior of the curve.

The transverse effect is marked by fractures, or deep valleys, where flow rivers, all of which present a partial variation in the curvature. The longitudinal effect is indicated by the lodes which continue a considerable distance parallel to the beds of trap, or cut them deeply at an acute angle.

Portage Lake is situated on a transverse fracture, or well-marked fault, on the two sides of which the series is not of the same height; it has been the principal effect produced by the upheaval in that part of the country. On the north and south of this fault the trap is a little turned, and the substance of the lodes does not come to surface except in the short longitudinal fissures which have allowed it to penetrate into the beds of the amygdaloid; so likewise the copper presents itself in this region as disseminated in the porous beds of the trap.

Apart from these relations, the deposits are found in the fissures produced by the upheaval, filled afterward by a phenomenon of which it is difficult to define the mode and moment of action.

This manner of explaining the disposition of the deposits of copper is rendered still more certain by the study of the outcrops and of the mines.

I shall first consider the lodes at Point Kewenaw, because these are most distinct, and those which show most clearly the influence of the enclosing rocks upon the nature of the gangue and the richness of the copper.

The lodes are well known from the greenstone to the borders

of the Lake, but south of the crystalline trap explorations have been made only at the foot of that chain of mountains. The lodes extend very far towards the south; they have been noticed on both sides of the Bohemian mountains, and some have commenced working them at Lake La Belle, near Mount Houghton, and at Lake Gratiot. The distance between the ports on the south coast, the difficulty of establishing convenient roads in such a broken country; the favorable results obtained in almost the immediate neighborhood of the greenstone, have determined the actual concentration of the mines in the region north of Point Kewenaw.

The explorations made at the south render it certain that the lodes traverse the entire country. We see them on the north in the bands of conglomerate which form the shore, extending under the waters of the Lake as far as the eye can discern them; south of the Bohemian mountains they disappear under the sandstones, which, apart from the probable obliquity of the plane of rupture, should cover in part the section of the upheaved series.

In the section which extends from the eastern extremity of the Point to the Albion mine, the transverse lodes are extremely numerous; their ordinary distance is from 200 to 600 metres, and all are almost perpendicular to the direction of the trap; some appear to present an exception, and to cut the beds at a more or less acute angle, but on studying them with attention, we can see that they are detached veins of a main lode, or that they only extend diagonally between two normal lodes.

Many of them can be followed by the outcrop from the conglomerate of the north to the sandstones of the south,—these are the main lodes; others, on the contrary, appear to be limited to certain zones of the series.

It is easy, in short, to perceive that in a country so sparsely inhabited and covered by virgin forests, we have been able to make only incomplete explorations; every day adds to the list of lodes which traverse all the series.

In passing from one series to another, or from a bed of trap to the next, the lodes do not afford offshoots; however, I think I could perceive in the eastern quarter, between Agate and Copper Harbor, that the lodes of the south do not correspond to those of the north, and show offshoots towards the west. I dare not affirm any thing in this respeet, in the absence of the requisite explorations; my opinion is founded only upon the characteristics of the outcrops. There is not an accordance in these, in the two quarters, which have the same direction at the north and at the south of the greenstone; on the contrary, there is a striking resemblance between many of the lodes explored towards the north, and those which towards the south are found about 200 metres further to the west. In the neighborhood of the valley of Eagle Harbor there certainly is not any offshoot.

Throughout all the middle zone south of the greenstone, and on the north even to the borders of the lake, the lodes appear very regular; on the other hand, south of the porphyritic mountains, they are very irregular, and generally less powerful than towards the north.

So far as regards their general features (*allure*), they are altogether analogous to those of our lodes in Europe. The principal vein is often accompanied by secondary ones detached at the head or foot; they unite to the first in depth and direction. In the amygdaloid beds the vein stuff penetrates a certain distance into the enclosing rocks; but in the compact series the walls are well defined, and very often the argillaceous (*sall bandes*) establish a separation very distinctly between the body of the lode and its walls. In the greenstone we no longer distinguish principal veins; the lodes are divided into a great number of small veins, which re-unite either in the crystalline rock or more usually in the amygdaloid in the south, or in the compact trap in the north.

The vein stuff is almost the same in all the lodes of the corresponding series; it is very different for each in the conglomerates and in the different varieties of trap.

Each zone of the series impresses, so to speak, on the lodes its peculiar stamp; certain beds of trap have likewise a great influence upon the richness in copper, and principally upon the state of combination of that metal.

Every lode has its particular richness greater in the determined zones; but in the same zones, the lodes which present the greatest analogies for the arrangement of the gangues, are very different in richness.

It is thence necessary to consider successively the relations which exist between the nature of the enclosing series, the disposition of the gangue, and the richness in copper.

Conglomerates.—In the conglomerates the lodes are not (*sall bandes*), and the gangue is almost always calc-spar, milk white, presenting very marked cleavages, mixed with a little quartz, and more rarely with sulphate of barytes almost black. In rare geodes they find magnificent calcareous crystals of all forms, and principally primitive rhomboid.

The secondary veins are not frequent; they diverge a little from the principal vein and reunite in a short distance. It would be more exact, perhaps, to say, that there are no secondary veins, but enormous fragments of rock enclosed in the limestone of the principal vein.

Compact and Amygdaloid Trap.—In the beds of trap the lodes are filled by calc-spar, felspar, some quartz, chlorite, angular fragments of all sizes of trap, more or less altered, by a red argillaceous matter, prehnite, laumonite, analcime, epidote and sulphate of barytes.

Analcime, some zoolites and sulphate of barytes are almost

always in isolated crystals or groups in the geodes. The epidote and laumonite are usually in very thin veins in the parts adjacent to the masses of copper, and rarely appear in well-defined crystals.

(To be continued.)

Art. IX.—REPORT OF THE SANTA CLARA MINING ASSOCIATION OF BALTIMORE.

Practical operations were commenced in September, 1856, and from the first Annual Report of the Company just published, we have the following account of the results and prospects.

On the 6th of September, 1856, the first furnace was charged, and, with a short intermission only, has since been in operation. A second furnace was built and charged for the first time on 13th Dec. 1856, and has since been uninterruptedly at work. The two furnaces had produced up to the 3d March, the date of our last report, 40,132 1-2 pounds of quicksilver.

With the result obtained from our smelting operations, although the yield of quicksilver, in consequence of the radical defects of the present system of reduction falls far below the assay, we have no great cause for dissatisfaction, seeing that we are obtaining the average yield of six per cent. from the outcrop, we may almost say, of our ores, our principal operations being conducted at a depth of only twenty-four feet below the surface of the earth.

The present defective system of reduction, from which there results so great a waste of valuable metal, has not failed to command the earnest and anxious consideration of this Board, and it is now conducting as well here as in California some experimental operations, upon an economical scale, and with the aid of science, for the purpose of ascertaining whether something may not be done to improve the yield from our furnaces.

The further erection of furnaces at the mines was arrested by the setting in of the rainy season, but orders have been sent to our agents to erect others as soon as the weather shall permit, and to increase the number to ten, which, even at the present low yield of our ores, will be able to turn out about 57,400 pounds of quicksilver per month. So far as we may be able to find a market in California, and our whole product has, up to the present time, been sold there, we shall obtain better prices than can be had for export, our sales having heretofore been made at from 65 to 70 cents. per pound.

The whole floating debt of the Company is about $16,000 only; and when taken in connection with such a result from our operations, as is above foreshadowed, its insignificance must be manifest.

With ten furnaces in operation, producing only 750 flasks or 57,375 pounds quicksilver per month, and this sold, say two-thirds at 45 cents, and one-third at 65 cents, we have for twelve months, $355,725 00, which, after deducting the estimated expenses of conducting the business, would leave a net result of upwards of eight per cent. upon the capital stock of the Company.

That a result far better than this has been obtained by the New Almaden Company, our neighbor, is well known to us. The Custom House books at San Francisco show that that Company exported last year quicksilver to the value of $880,000, and it had besides for the major part of the year the undisputed possession of the California market, the extent of which is not accurately known, but is believed to be very large.

We may here observe that some of the ores taken from our mine have been of very great purity, and would probably have yielded by assay 60 or 70 per cent., but the greater part has been of course of a much lower grade. It would, perhaps, be safe to place the average assay of our ores at 20 per cent., whilst it will be seen, as hereinbefore stated, that the yield from our furnaces barely averages about 6 per cent. It may also be well to bear in mind that it is a law of the Cinnabar formation, that as the veins are followed into the bowels of the earth, each successive pocket is found to increase in size and purity.

The preceding estimate of the result to be had from the operations of ten furnaces is based upon the present low yield of 6 per cent. from the two furnaces now at work, but this result may be greatly improved from several sources. The first furnace built proved quite defective in several respects, and although efforts have been made to remedy these defects, they have never been entirely successful. The second furnace, built with the advantage of the experience acquired in erecting the first, proved to be better, and we hence conclude, that with more light upon the subject, we may properly look for further improvement in this branch of our business, where under the present barbarous system of reduction there now occurs the great loss of 14 per cent. between the average of the assay and the yield. Then it is but natural to expect, that as we extend our excavations further into the earth, we shall be materially improving in the character of the ores taken out, and that our average yield will also be improving from this cause.

The estimate based upon the operations of ten furnaces, at the present low yield of our ores, would show a net profit of $250,000, or more than 8 per cent. upon the capital stock of the Company; while, when our ores shall have increased in richness to a par with those of the New Almaden, these same ten furnaces would, upon the same scale of prices, produce a gross result of about $1,000,000, giving for net profits some $700,000, or 23 1-3 per cent. upon the capital stock of $3,000,000.*

* Since this Report was prepared we have received official intelligence

This, to those unacquainted with the extraordinary productiveness of quicksilver property, may seem somewhat extravagant; but these calculations, we feel satisfied, have been more than justified by the results obtained from the New Almaden Mine, to which we have hereinbefore referred.

It is, to be sure, possible that the increase in the production of quicksilver as contemplated by our operations, may somewhat affect the price for a while, but unless there shall arise an unwise competition for sales, the price being now very low—less than one-half—as compared with the price it commanded but a few years since, there need not necessarily be any great depreciation of the article. And if indeed there shall be such a moderate reduction in the price of this article, as shall lead to its being employed in the elimination of silver from the vast quantities of poor ores, which now lie neglected all through Mexico and South America, it may be a question whether, so far as an increased supply of the precious metals may be considered a good, such moderate reduction in the price of quicksilver is not highly desirable. It could not fail itself to be reacted upon in common with all other exchangeable values, by the increase in the basis of value, which itself would thus be made to promote.

Under no circumstances can we permit ourselves to believe that, with ten furnaces in successful operation, the earning of a dividend, of at least 8 per cent. per annum, would be a matter of any uncertainty; and that it shall not be increased largely from year to year, will depend upon a greater variation in the value of our product than we can bring ourselves to anticipate.

It may not be uninteresting to you to know, that should the supply of quicksilver, specifically, become anywise excessive, we have a ready recourse and corrective, in the conversion of our ores into vermilion, an article of great value and of as ready sale as the quicksilver itself. It is well known that vermilion equal in quality to the best Chinese has been produced in France, and there is no reason, therefore, why we should not produce it of like quality in California, should the occasion arise.

As it is known, however, from the most reliable and authentic sources, that the country acquired from Mexico by the United States and known as the *Gadsden purchase*, is studded, throughout much of its extent, with perhaps the richest deposits of gold and

from our agents in California, of the very successful use of an iron retort in reducing our ores, and the result of repeated experiments has been to demonstrate the fact that, with retorts, an average of at least 25 per cent. can be had from the present quality of our ores, likely, of course, to be increased as the ores improve when taken from a greater depth.

Two benches of three retorts each, will yield annually at an average of 25 per cent. from the ores, 327,60 pounds quicksilver on a gross, even at the low price of 40 cents per lb. of $131,040. By increasing the number of retorts at our pleasure, we can multiply the products of our mine to an extent limited only by the quantity of ore found, and by the state of the quicksilver market.

silver which have ever been discovered; and, as it is also known that the countries of Central America, which seem destined, at no distant day, to come under Anglo-American development, also abound especially in silver mines of very great promise, it may be but reasonable to anticipate an enlargement of the demand for quicksilver *pari passu* with the production, and any apprehension as to the depreciation of its value may therefore be wholly unfounded.

You have been informed that a certain title to your property was derived under a deed from Mr. James Eldredge to Robert C. Wright and others. The consideration to Mr. Eldredge for this deed, was the personal bond of Messrs. Edward S. and Henry P. Townsend, for the sum of $270,000, these gentlemen claiming certain equitable rights in the property, and the Association apportioning to them and Mr. John F. Pickrell, by the fourth article of its fundamental Articles of Consolidation, the sum of $533,333 33 1-3 of the capital stock in consideration, as set forth in the fifth article of said Fundamental Articles of Association, of the said personal bond of the Messrs. Townsend to Mr. Eldredge. The parties, to whom Mr. Eldredge made the deed for the title he claimed, mortgaged back to Mr. Eldredge the title derived from him, as collateral security for the payment to be made to him by the Messrs. Townsend under their personal bond; but it was always understood that Mr. Eldredge's claim was to be satisfied from the stock of the Company, and in this view $181,000, upon the basis of $1,000,000 capital, equal to $543,000 upon the basis of the increased capital of $3,000,000, were specifically reserved, by the fifth article of the Fundamental Articles of Consolidation, to idemnify the Company against the mortgage claim of Mr. Eldredge.

Mr. Eldredge's mortgage claim remains unpaid, the Messrs. Townsend having failed to meet their bond, and your Board contending, that by reason of the delay in the surrendering to us of the property, and for other good and sufficient reasons, no instalment of the mortgage is now due. The matter thus standing, your Board is pleased to be enabled to inform you that an arrangement has been made with Mr. Eldredge, by which it is relieved from all concern in relation to this mortgage, he having consented for certain considerations to postpone his demands to such distant period as leaves no doubt of the easy liquidation of the claim out of the revenues of the Company, if not out of the large amount of stock, reserved in the hands of the Company, as indemnity against his claim, and which we consider fully adequate for this object.

With a title therefore to your property, confirmed by the U. S. Land Commissioners, in which are quieted all adversary claims, and fortified still further by the shield of school land warrants, the highest title known in California, with which we have had

all the valuable portions of your property covered, so that in the contingency of your being declared to be outside the grant of the Capitancillos Rancho, upon which we claim to be located, and upon public domain, you would still be able to hold as against the United States: possessing as we believe a property abounding in inexhaustible deposits of rich cinnabar, holding a position between the New Almaden and the great matrix of the cinnabar-formation of California, which we think will be found in the Sierra Azul, towards which our explorations are now tending, and from which our corner of the Rancho de los Capitancillos is only separated by a small stream, we cannot forego the present occasion to congratulate you upon the most auspicious future, which in our judgment seems to wait upon your enterprise.

In connection with the reference which has been made to the covering of your property with school warrants, we take the occasion to say, that as soon as we were led to believe, from the discovery of important deposits of cinnabar upon the margin of the Arroyo Seco, the little stream which forms one of the boundaries of the Rancho de los Capitancillos, and separates that Rancho from the Sierra Azul, that the veins extended under the bed of the stream and into the Sierra, we caused all the accessible and valuable points in the Sierra also to be covered by school warrants, and the necessary steps to be taken to secure a perfect title to this valuable portion of the Sierra Azul.

It may be proper also to state that our principal mining operations are now conducted under the bed of the little stream referred to, lying directly at the base of the Sierra Azul, which here rises to a height of several thousand feet, and the further we descend under the base of the mountain the richer and more abundant are found the deposits of ores.

LOCATION OF THE SANTA CLARA OR GUADALUPE MINES.

These mines are situated in Santa Clara County about fifty miles from San Francisco, and within twelve miles of the Embarcadero or port of Alviso, near the head of San Francisco Bay. Between the mines and the port of Alviso there intervenes a beautiful level or prairie country, and an excellent road passing through the town of San Jose, furnishes an easy transit from our mines to the port whence our quicksilver is shipped to San Francisco.

The Santa Clara or Guadalupe Mines are in the same range of hills with the famous New Almaden Mines, and distant about four miles therefrom.

This range of hills is a spur or off-shoot from the Sierra Azul, and our mines occupying a position between the New Almaden and the Sierra Azul, and the ore veins upon which we are now working tending towards and being at the base of the Sierra, we are led to believe that we occupy a better position than the New

Almaden with reference to the matrix of the cinnabar formation.

Upon our property has been found an abundant supply of limestone and brick clay, the former considered useful in the reduction of our ores, and both important to the construction of our furnaces.

Of wood, so necessary to the smelting process, we have also an abundance.

The officers of the Company are as follows:

President—Robert C. Wright. *Treasurer*—James J. Lawn. *Secretary*—Vivian Brent. *Directors*—Robert J. Walker, Henry May, Robert J. Brent, Frederick A. Levering, James J. Lawn, Wm. F. Dalrymple, R. D. Cullen, John Tucker, Robert C. Wright. *Agent at San Francisco*—Henry F. Thompson. *Superintendent at the Mines*—Eben Faxon. *Mining Engineer*—Charles Heusch.

Art. X.—GEOLOGY—A LECTURE BY PROF. PHILLIPS.

Prof. Phillips concluded his interesting course of lectures on leading questions in geology, with the consideration of "Geological force and time, exemplified by waste and renewal of land, and other changes within the historical period." Numerous views of rocky scenery were displayed, exhibiting waterfalls, caverns, remarkable cliffs and rocks, to exemplify the waste occasioned by the action of water and the atmosphere; the whole of the variegated scenery of nature, as Mr. Phillips observed, having been formed by geological force in the progress of time. One object for which these drawings were shown was to point out the foundations on which calculations rest respecting the periods during which geological changes have taken place. He alluded in the first place to some speculations of Prof. Thompson, of Glasgow, who undertook to prove by mathematical formulæ the exact period of time since granite was launched into space in a state of fusion; but the data of such calculations were assumptions, therefore the deductions from them could only be regarded as speculative. The action of water impregnated with carbonic acid on the limestone rocks of Derbyshire and Yorkshire, formed the data of many of Prof. Phillips' calculations, the wearing away of the rocks being in some instances clearly indicated by the chasms formed by waterfalls at the heads of valleys. The retrogression of a waterfall, as it wears away the rocks, has in many cases been measured; and supposing the fall of rain in former ages to have been the same as at present, the time may be calculated during which the water has thus been working its way, and bringing the point of fall nearer its source. The rocks at the

Falls of Niagara present a remarkable instance of a water-worn chasm, in which the time occupied in the formation may be estimated with probable accuracy. The distance of the Falls from Queenstown, where it is supposed that the river Niagara originally fell over the rocks that rise precipitously from the plain, is seven miles; and it has been observed that the point of fall approaches the upper lake at the rate of 40 yards in 50 years. Assuming, therefore, that the same causes have continued in action, a period of 9800 years must have elapsed since the Niagara fell over the rocks at Queenstown. Other indications of the effects of geological force and time are to be seen in the deposition of sediment from rivers. Near Matlock a large hill of limestone has been formed by the deposition of lime held in solution by water and carbonic acid, which must have required thousands of years for its deposition. The sediments deposited by rivers are not, however, sufficient to account for the excavation of valleys. This is particularly evident in those rivers that fall down valleys into lakes. The river that flows through Burrowdale valley, into Keswick lake, and the fall of the Rhone into the lake of Geneva were mentioned as particular instances; for the quantity of sediment deposited in the beds of those lakes is quite insignificant compared with the mass of matter excavated in the formation of the valleys; and the limpidity of the water at the further ends of the lakes shows that the whole mass of sediment brought down by the rivers had been deposited and not carried beyond the lakes into the sea. As evidence of the long periods of time that must have been occupied in producing geological formations, Mr. Phillips noticed the Wealden beds in Kent, 800 ft. thick, which were probably deposited by some river as large as the Ganges, of which that portion of the kingdom formed the mouth. Comparing the mass of deposit with the yearly sediment of the Ganges, it was shown that it must have been the accumulation of many thousands of years. Referring to the coal formation, Mr. Phillips again noticed the long periods that must have elapsed during the formation of a single seam of coal, supposing the constitution of the atmosphere to have been always the same as at present; but he said there are several reasons for supposing that the air in ancient times contained a larger portion of carbonic acid. Assuming that coal was formed from vegetable matter, and that vegetables derive all their carbon from the atmosphere, it could be shown that the coal-beds of Europe and America alone contain a much larger quantity of carbon than is contained in the whole atmosphere of the globe. It may also be assumed that, when the temperature of earth was higher, there was greater evaporation and consequently a larger fall of rain. A greater quantity of rain would, of course, occasion a more rapid wearing away of the rocks, and this would, in some degree, alter computations founded on existing causes of disintegration; but even supposing the action of

geological force to have been very much greater than at present, it would most probably have required a period of time to be computed by hundreds of thousands of years to account for geological phenomena, supposing them to have been produced by progressive changes.

Prof. Phillips, in a subsequent lecture before the Royal Institution, in considering the causes of the high temperature of the globe in ancient geological periods, attributed it chiefly to internal heat, and he (the lecturer) stated the reasons for holding that opinion. In the first place, the figure of the earth shows that the mass was originally in a fluid or semi-fluid state, to enable it to assume an oblate spheroidal shape by rotating on its axis. Second, the evidence of volcanoes which at long distant intervals have ejected masses of rock, which are of the same quality in the same district, but are different in different districts. These igneous eruptions have been continued from periods long antecedent to the deposition of the tertiary strata. In the next place, there is the direct evidence of the internal heat of the globe derived from the increase of temperature in descending from the surface. It has been determined by numerous carefully conducted experiments in deep mines that, at a depth of 100 ft. variations of the seasons on the surface cease to be felt, and that the heat increases on an average about 1° degree of Fahrenheit's thermometer for every 60 ft. of depth. The temperature of water from deep Artesian wells confirms the evidence derived from mines. The water of the Artesian well at Grenelle, in Paris, which is 1,791 English ft. in depth, is 81° when the temperature at the surface is 51°. Assuming, therefore, that the same increase of heat continues in descending, it is easy by computation to determine at what depth the heat of boiling water would be obtained; and Mr. Phillips conceives that the temperature at lower depths augments in an increasing ratio. Calculating the increase, however, at the known rate of one degree in 60 ft., it may be estimated that at a depth below the surface of only seven miles all substances must be red-hot. In applying the ascertained internal heat of the globe to explain the greater temperature of the surface in geological periods, when tropical plants grew in the temperate zone, Mr. Phillips laid considerable stress on the influence of a small degree of heat in producing a greater amount of vapor in the atmosphere, which would thus obstruct the radiation of the heat from the globe into space, and must have occasioned a higher temperature and a state of moisture favorable to the growth of such plants as are found fossilized in the coal beds and the strata lying above them. Mr. Phillips next considered the nature of the slaty cleavage in rocks. The peculiar structure of slate rocks, which causes them to split in parallel directions, is independent of the lines of stratification; and Mr. Phillips showed numerous diagrams and specimens to prove that this cleavage structure was

produced by pressure and heat before the secondary strata were deposited. Among the illustrations in proof of this opinion were the forms of fossil trillobites, which when lying parallel to the line of cleavage were greatly elongated, and when lying perpendicular to it were much compressed. The opinion that the slaty cleavage of rocks was due to compression has also been confirmed by direct experiments, in which substances mingled together and when compressed had a tendency to split in lines at right angles to the pressure. A recent experiment by Dr. Tyndall also proves that the same uniform substance may have a cleavage structure given to it by compression. The substance operated on was white wax, and after it had been subjected to great pressure, it split into thin leaves in a direction at right angles to the compressing force. Many rocks exhibit signs of pressure without having a slaty cleavage, in which case Mr. Phillips supposes there was an absence of sufficient heat to produce that effect, the combination of great heat with great pressure being required; and he conceives that if the London clay had been subjected to the same actions as the slate rocks, it would have been equally hard, and would have had a similar slaty structure.

COALS AND COLLIERIES.

SCHUYLKILL COAL TRADE.

The quantity of coal sent by railroad and canal from Jan. 1 to June 25, 1857, is:—

	Tons.
By railroad	914,739·16
" Canal	396,756·06
Total by canal & R. R.	1,311,495·22

Shipments to same period last year:

By railroad	1,004,044·16
" Canal	402,374·04
	1,406,418·20
	1,311,495·22
Decrease in 1857, so far	94,922·18

LEHIGH COAL TRADE FOR 1857.

Total amount of shipments for 1857, to June 20th:

By Canal	223,425
By Lehigh Valley Railroad	190,981
Total	414,406

Shipments to same period last year:

By Canal	338,299
By Railroad	43,011
	381,310
Increase in 1857, so far	33,096

MARYLAND COAL TRADE.

By Cumberland Coal and Iron Co.'s Railroad, to June 20th:

	Tons.
Cumberland Coal & Iron Co.	61,515·06
Percy & Co.	000·00
Ætna C. Co.	7,652 11
Total	69,167·17

By Cumberland and Pennsylvania Railroad:

Frostburg Coal Co.	8,424·11
Borden Mining Co.	29,002·10
Alleghany Coal Co.	15,596·09
Union Coal Co	721·15
Total	53,745·05

Total from the Frostburg region for the week, 5,599·12 tons; and since January 1st, 122,913·02 tons.

By George's Creek Railroad.

George's Creek Co.	30,350·01
Swanton Co.	3,297·13
American Co.	40,520·08
Franklin Coal Co.	16,494·15
Pickell Coal Co.	4,329·01
C. E. Detmold	11,813·16
Barton Coal Co.	261·01
Total	107,066·15

By Hampshire Coal and Iron Co's. Railroad.

Hampshire Co.	26,750·12

Total from the Westernport region for the week, 7,918·06 tons; and since the 1st January, 133,817·07 tons.

Total from the whole coal region for the week, 13,512·18 tons; and for the year, 256,730·09 tons.—*Cumberland Telegraph.*

REPORT OF THE DELAWARE AND LACKAWANNA AND WESTERN R. R. CO.

Mining and Coal Shipments.—The Report of the general coal agent exhibits the following:—

The total sales during the year, amounted to 276,221 4-20 tons, producing the gross sum of			$955,125 81
Amount received for Rents			4,538 92
Value of Coal on hand, Dec. 31, 1856, (28,605½ tons,)			101,299 70
			$1,060,964 43
Value of Coal on hand, Dec. 31, 1855, (36,932 19-20 tons,)	$127,906 07		
Stock at Diamond Mines,	735 00		
		$128,641 07	
Sundry deductions, &c.,		50 00	
Total expenses for mining, repairs of fixtures, transportation, superintendence, &c., during the year,		784,065 83	
			912,756 90
Showing the net revenue,			$148,207 53

General Agent's Report.

Coal Department.—The Company have, during the year, resumed the entire control of their own Mines, which, therefore, can now be worked more in accordance with the convenience of the Railroad and wants of the market.

These mines are now in condition to deliver one thousand tons per day, should this amount be required.

Other parties, from whom we purchase coal, have contracted to deliver, during the year, an aggregate of half a million tons. And, in addition, the Lackawanna Railroad Company and the Union Iron and Coal Company expect each to send one hundred thousand tons more; making a total, including our own Mines, exceeding one million of tons, which we would remove if pre-

pared to transport it. There need not, therefore, be any fear, or even doubt, of a full supply of coal.

Notwithstanding this, I believe it to be our best policy to carry forward to completion the work now in progress for increasing our ability of supply, as a liberal provision in this respect may prevent derangement of our business, should other parties fail to perform. It will also be found to have a good effect in regulating the price of what we have to purchase.

At the commencement of 1856, the work in progress for opening coal was one slope, one single and one double shaft. The slope is now finished, and in good working condition. The single shaft is finished down to the coal—machinery complete, and gangways commenced; can soon deliver coal. The double shaft is still in progress, and will be put in working condition during the year. This shaft is intended to work two seams, and, when in operation, can deliver 600 tons per day. In addition to this, we have made two gangways into an upper coal, (of good quality, six feet in thickness.) This coal is all above water level, and therefore profitable to work. It must be taken out before the lower coals; otherwise we will find it difficult, if not impossible, to mine it.

The estimate of expenditure to complete what I would deem necessary during the year, will probably be $70,000.

In my last report I adverted favorably to the comparative quality of our coal. In evidence of which, we have sold during the year twenty-one thousand tons along the line of the Morris Canal, and much more would have been sold if the sizes wanted could have been supplied. I consider, therefore, as certain, that our coal will soon successfully compete with the Lehigh for general use.

Having established beyond all reasonable doubt that the supply of coal will be ample, it becomes important to ascertain how much can be sold and sent to market in 1857. There has been sold west and north the past year 188,000 tons; we may, therefore, safely say that this market will require 200,000 tons in 1857. This amount can readily be supplied, and may, therefore, be assumed as certain.

The Eastern market, however, is more difficult to estimate, and therefore I assume that we can sell all that we can transport over the southern division of our road. Taking, therefore, into consideration such aid as we shall get from portions of the second track now in progress, and the telegraph line which is completed, we shall be able to send east some half a million of tons. Including what is sent by the Lackawanna and Union Companies, our coal business for the year, east and west, will be 700,000 tons. This may appear a small estimate; but it must be kept in view that, in addition, we are doing a large freight business, which in 1856 amounted to some 130,000 tons, exclusive of coal: and this year it will in all probability reach 200,000 tons.

The passenger business occupies also a portion of the capacity of the road; so that, all things considered, the estimate of coal transit is not so small as may appear at first sight.

The gross revenue from passengers in 1856, is - - - -	$122,984 99
Estimated amount for do. in 1857, - - - -	180,000 00

Having hastily glanced at the amount of business that we expect to accomplish during the present year, I will proceed to describe, in general terms, the condition of the several divisions of the road that this traffic has to pass over.

1st.—Cayuga and Susquehanna.—This Division is in better condition than it was in 1856—all the bridges having been rebuilt upon an improved and more durable plan. A new and enlarged piling-ground, together with increased facilities for the loading of boats, has been constructed at Ithaca since the close of navigation; so that this division could do a much larger business than will be required from it.

2d.—Northern Division.—This has also been improved during the year by

the filling up of all the trestlings with earth; thus making a permanent and safe road-bed. Three and a half miles of old rails have been taken up, and replaced with new ones of larger pattern—thus finishing the distance from Scranton to Clark's Summit (seven miles) with a track of the most permanent kind, where most used and wanted. The drainage of the road-bed upon this division has been put in very good condition, and two and a half miles of switch-track has been added during the year—making in all fifteen (15) miles; this, however, includes the switches at Great Bend, Scranton, Diamond Mines, &c., &c. This division has, therefore, all necessary facilities for doing its business with economy and despatch. It may be proper here to suggest, that, in view of the work that will still have to be done to these embankments, after the spring rains has settled them, it might be advisable to make an appropriation of ten thousand dollars, to finish up the construction account of this division, so that for all future expenditures the Board would make special provision.

3d.—*Keyser Valley Branch.*—This Branch has been constructed during the year, and connects the Hampton and other Mines with the Northern Division. It is now in good working condition. Its length is about three miles. The coal from these mines is of very good quality, and is conveniently situated for the western market.

4th.—*Southern Division.*—This division is sixty-four miles in length, extending from Scranton to the Delaware River. The bridges, tunnels, culverts, &c., are all constructed for double track, and the road-bed is also far advanced towards completion, with reference to the same result. This portion of your road has always been looked upon as destined to become the great avenue of transit from the coal-fields of the Lackawanna and Wyoming Valleys to tide-water. And hence great pains have been taken to make it one of the best roads in the country.

At this time one track is so far finished that it is in very good condition, the superstructure being laid upon a foundation of broken stone, or gravel, and well ballasted. The iron rails weigh 75 lbs per yard. Six miles of the second track is laid, extending from Scranton to Greenville; while six and one-half miles more is put down at different points, as switches for the passing of trains. In all twelve and a-half ($12\frac{1}{2}$) miles of the second track is in a measure finished. There are iron rails and cross-ties purchased for twenty-five miles more of this second track, which we hope to lay down during the summer.

Under all the circumstances, therefore, and in view of the great amount of tonnage that will press to market faster than we can provide for it, there can, it seems to me, be but one opinion in reference to finishing the second track the whole of the way, whenever the Company can provide the means without too much sacrifice.

5th.—*The Warren Railroad.*—This road being now in the control of this Company, it is proper here to say, in reference to its condition, that full one-half is ballasted with gravel and broken stone, and is in good order. That portion not ballasted will require this to be done as early in the spring as the season will permit.

More switch room will be necessary along this road, for the convenient passing of trains, more particularly at its junction with the Central Railroad of New Jersey. Here we have a turn-table, and engine-house with six stalls, and a commodious boarding-house for the men employed upon the trains. There is still wanted a small work-shop, (which will be attached to the engine-house,) for the repairs of engines and cars, as also a passenger car-house. And, in connection with the Central Company, there needs to be built a convenient dépôt, where passengers can be kept with comfort in the event of missing a connection with the trains.

At Washington, upon the Morris Canal, we erected some schutes, for the loading of boats from the cars. But inasmuch as our business is expected to be enlarged at this point, it is intended to construct, during the coming spring,

a piling-ground similar to that at Ithaca, with the addition of pockets, from which boats can be loaded with despatch, as we find this an important inducement for them to stop and take in loading. The sales for the year at this point are estimated at from thirty to forty thousand tons.

6th.—Elizabeth Port.—Here we have completed the three piers that were in progress in 1855, and, in addition, are preparing a large deposit ground, to prevent the delay of cars when vessels are not on hand. It is anticipated that these provisions will be sufficient for the business of 1857. But as this will be largely increased the coming year, it may be found necessary to construct another pier during the summer.

Rolling Stock.—For the details of this portion of our business, see the Report of Mr. Marvine, Acting Manager of Machine and Car Shops and Foundries.

The number of engines and cars now on hand, together with those in progress of construction, will be equal to the accomplishment of all the business that is contemplated.

I have thus given, as briefly as possible, a general view of the condition of the Company's Works, and their capacity for the business we intend to do. The views expressed are mainly concurred in by the present superintendents, and we hope to show that they may be relied upon.

Respectfully submitted,
JAMES ARCHBALD,
General Agent.

General Coal Agent's Report.

Diamond Mines.—These mines have been worked by Mr. Thompson Peckens, under his contract, up to the first of September, when it became necessary for the Company to take possession of them. Since then, they have been worked, on Company's account, in a satisfactory manner. The yield for the year has been 108,794[12] tons.

The construction of the No. 2 or double shaft, has not been pushed with any degree of rapidity, as there was no immediate necessity for doing so; nor did the managers urge its early completion.

The "C," or 5 feet Vein of Coal, has been opened above water level, by two drifts, both of which we are now working. This coal is of good quality, and is run to the old crackers without hoisting, and is there broken, and screened. We are now prepared to do a considerably increased business at these mines.

The entire expenditure at the Diamond Mines, on construction account, has been $38,461 26, including amounts paid for mules, implements, &c., necessary for working the mines on Company account. The estimated expenditure for the current year, 1857, is $57,000. This amount is calculated to cover the whole expense to be incurred in finishing the No. 2 shaft, and to pay for all the mine-cars, mules, &c., that will be needed for an increased business.

Bellevue Mines.—These mines have been worked on Company account, as heretofore, and 36,237[6] tons have been sent to market from them. The No. 1 shaft and coal-breaker have been completed. We are now driving the headings for mining. The entire expenditure chargeable to construction account has been $37,285 88. The estimated cost for 1857 is $9,000, including amount required for mules, mine-cars, strap-rails, &c.

We are now exploring the "E," or Diamond Vein of Coal, by boring, &c., and it may be desirable to commence the mining of this vein during the year. Should this be done, the above estimate must be increased by an amount sufficient to pay for the necessary openings, machinery, &c.

Coal Purchased.—There has been received, during the year, as follows:—

From Clark's Mines,	tons,	59,749.05
" Swetland's Mines, (Lewis & Howell, Contractors,)	"	20,942.17
" New-York and Pa. Coal Co. Mines,	"	14,037.17
" Luzerne Coal Co. Mines,	"	52.215.02
" Hampton Mines (G. H. Coursen,)	"	6,674 04
" National Anthracite Coal Co. Mines,	"	242.06
	"	153,861.11

Recapitulation.

From purchased as above,	tons,		122,861.11
Coal mined by the Company, viz.:—			
From Diamond Mines,		108,794.13	
" Bellevue "		36,237.06	
			145,031.19
Total,	"		267,893.10
Total, in 1855,	"		188,865.09
Equal to an increase of 42 per cent.,	"		79,028.01

Sales and Stock Remaining on Hand.

The Stock of Coal on hand, December 31, 1855, was,	tons,	36,932.19
Amount (as above) forwarded in 1856,		267,893.10
		304,826.09
Of which there was sold and delivered		280,508.01
Leaving stock on hand, December 31, 1856,	tons,	24,318.08

The Coal sold above was delivered as follows:—

At Scranton, and on the line of the Northern Division,	17,200.07
" Binghamton, for supply of points on Chenango Canal,	51,665 08
" Ithaca—(for Rochester, Buffalo, &c., &c.,)	84,986.18
" Various points on N. Y. & E., and connecting roads,	33,881.19
" Elizabeth Port,	64.109.07
" Washington Basin, on Morris Canal,	21,558.08
" Line of Southern Division and Central R. R. of N. J.,	7,105.14
Total,	280,508 01
Total, in 1855,	160,714.15
Increase,	119,793.06

More coal could readily have been mined, sent off, and sold, if facilities for its transportation had been more ample, particularly from the Company's mines.

The sales of our coal to the north and west, as compared with those in 1855, have increased equal to 17 *per cent.*, and would readily have reached the estimate made in my former report, of 25 *per cent.*, had it not been for the delay in boating, during the early part of the season, caused by the extraordinary detention on both the Erie and the Chenango Canals. I have good reason to believe that had it not been for these difficulties, we would have exceeded the estimate then made. Our sales in this direction, for 1857, may be set down at about 210,000 tons.

It is with renewed pleasure I am able to state that the collections have been made with the usual promptness, and it must be gratifying to the Company to know that we have met with no losses, save for a very few car loads.

The farms and tenements of the Company, in my charge, have been rented, upon satisfactory terms, and have been kept in good condition and repair.

Further contracts for the purchase of coal have been made during the year, which, with former contracts, and the increased supply reasonably expected from the Company's mines, together with that which will be forwarded by parties on private account, will furnish a quantity adequate to the supply of the market.

Respectfully yours,
JOS. J. ALBRIGHT,
General Coal Agent.

REPORT OF THE CUMBERLAND COAL AND IRON COMPANY.

June 1st. 1857.

The report of the Cumberland Coal and Iron Company is as follows, which, considering the attending circumstances, is not unfavorable:

In this, my third annual report, I regret that, owing to defective dams

(four and five on the Potomac River) and consequent scarcity of water during most of last summer, the early closing of the Canal, and harbors of Baltimore and Alexandria by ice for a period of more than two months, it is not in my power to give a more favorable result of the business for the fiscal year ending on the first ultimo.

The quantity of coal mined and sent to market during the past year was 202,067 tons, against 189,760 tons for the year preceding, which netted, after deducting *all expenses*, eighty-eight thousand four hundred and sixty-seven dollars and seventy-five cents. This increase would have reached the additional quantity of 42,000 tons, but for the causes named; leaving that amount of uncompleted orders at the termination of navigation.

The advance of fifty cents per ton on freight made by the Baltimore and Ohio Railroad Company over that road, on the first of October last, somewhat lessened the demand for shipment at Baltimore, and entailed a loss upon the coal contracted for at that point.

The old dams referred to, as feeders to the Chesapeake and Ohio Canal, suffered severely by the ice-freshet of February last, portions of them being carried away; the repairs, however, will, without doubt, be completed so as to enable boats to pass on or before the tenth instant, and the entire dams will, I am gratified to state, be superseded, at an early day, by others of *stone*, which will be *durable structures*, rendering this important work (now under the most energetic management known since its construction) equal, if not superior, to any similar work in this country. To its indefatigable President, William P. Maulsby, Esq., and his Board of Directors, you owe a debt of lasting gratitude for the promptness, ability, and zeal with which they have prosecuted the necessary repairs and work on new stone dams.

The "Commercial Mart" property at Cumberland, of which I made mention in my last report, costing originally forty thousand dollars, and hitherto unproductive, has been improved by the completion of an extensive shipping-wharf 630 feet long by 42 feet in width, having three tracks, with the necessary fixtures for loading five canal-boats in the same period of time occupied in loading one under former arrangement. The advantages of this improvement are, that it lessens the cost of shipping, saving time and labor without injury to the coal by breakage; the boats are loaded and trimmed without *rehandling;* thus forwarding the coal in a greatly improved condition, and the time of trip to each boat lessened at least one day.

This valuable improvement to the Company will save an annual disbursement for wharfage and expenses of from eight to ten thousand dollars, and will largely add to the value of the remainder of its Canal property of Cumberland. The cost of the wharf is about eighteen thousand dollars.

A commodious, most desirable, and fully improved wharf-property at Baltimore, has also been purchased at a cost of sixty-five thousand dollars, the interest of which is a less sum than the amount now annually paid for wharfage, with the certain contingency of a proportionate increase of rent in any improvement in our business, and at the same time placing the Company in permanent possession of a property complete and adequate to any amount of business.

These wharves, with the one at Alexandria (which, owing to the unaccountable short-sighted policy of the *authorities* and property-holders of Georgetown, has become important)—all new and substantial—will enable the Company to ship its coal with greatly-increased despatch and economy, and render it entirely independent of other and opposite interests.

The extension of the road to the Astor mine will, with other improvements being made this season, render accessible the whole of the Company's lands, a sale of a small portion of which, not required by the Company within the next century, to extinguish the balance of its bonded debt, now reduced from \$825,000 to \$467,000, less \$112,000 as per statement, is in my opinion worthy the consideration of the Board. This accomplished, the Company could, in the absence of any unforeseen casualty, commence after this season the payment of regular semi-annual dividends.

There was purchased and built during the past year, forty-two first-class iron hopper cars; fifteen new canal-boats, and twenty-five rebuilt; making a total of one hundred and forty-one cars and seventy-six canal-boats; together with four hundred and fifty-seven mine cars, five first-class and two second-class locomotives. This equipment is equal in capacity to the shipment of from 300,000 to 350,000 tons of coal per annum, without any further outlay save the purchase of one locomotive at a cost of about $10,000.

The increasing consumption of bituminous coal in locomotives, promises a future demand that can only be supplied from the Cumberland region; and no other coal for the purpose is comparable to it. Notwithstanding the pretensions of others are frequently thrust upon the public in competition with your own, I have, after careful examination, come to the conclusion that *we need fear no permanent competitors in the Bituminous Coal market.* All the experiments prove it more advantageous than any other.

The prostration of railway securities has induced more inquiry into their management, and the attention of their directors has been pointed to this most important branch of economy. Their financial condition, together with the obstinacy or indifference of officers and employés, have much retarded an improvement, that to our eastern and northern roads is essential to their profitable working, and in some instances, to their existence.

Railroads running out of this city could, by the adoption of proper coal-burners, give dividends to their stockholders. Valuable inventions are not necessarily quickly adopted or brought into general use; and improvements in locomotives involving so large an outlay of capital, require much time and labor to introduce. Much, however, has been accomplished in the introduction of coal-burners upon various roads, and I have yet to learn an instance where one has been unsuccessful. The orders now for motive power (coal-burners) are beyond the ability of the patentees of one class of engines to supply.

The great cost of wood; the expenses in handling, sawing, and piling; the storage in costly sheds, occupying valuable ground; risk from fire, theft, and loss of interest, form an item in the economy of railroads that hitherto has been singularly overlooked.

One of the best-managed railroads in the East (the Providence and Worcester), in their last exhibit state:

"The whole equipment of the road is in superior condition, and has been increased during the year by the addition of twenty new freight-cars built in the Company's shop, and the substitution of a new coal-burning engine for freight, called the 'Slater,' in place of one of the smaller wood-engines, exchanged in part payment.

"The above coal-burning engine has been running daily during the whole past year with very satisfactory results; and another of the same description, called the 'Mason,' has been recently purchased by exchange of one of the wood-engines in party payment, and is now daily at work on the road. These engines are of the 'Boardman Patent' for burning coal, for which use the semi-bituminous coal from the mines of the Cumberland Coal and Iron Company seems peculiarly adapted. A third engine of this kind is about to be purchased. These three engines will perform all the freight service, which amounts to two-thirds of the entire locomotive service of the road. From repeated and careful experiments, the saving of fuel by these engines, compared with the best wood-engines of the Company, is more than fifty per cent. When to this is added the incomparably greater safety against fire, and the important saving in wood-yards, wood-sheds, insurance, &c., the Board believe the introduction of coal-burning engines will become general on New-England railroad, and will greatly increase the value of such investments." This Company offer for sale all their wood-burning engines.

It gives me pleasure to state, that besides having reduced the bonded debt to the sum stated, all the improvements referred to have been accomplished *without*, as is too common with *incorporated companies*, adding to its capital,

or creating any new debt; and all of which has added so much to the constantly increasing value of your property.

For financial condition of Company, I refer you to statement annexed.

All of which is respectfully submitted.

A. Mehaffey, *President,*

The Cumberland Coal and Iron Company in account with its Treasurer, May 1, 1857.

To capital stock,	$5,000,000 00
" 6 per cent. mortgage-bonds due in 1864,	467,000 00
" bills and accounts payable,	205,186 42
	$5,672,186 42
To balance,	266,075 94
By mining lands,	$4,500,000 00
" Eckhart Railroad,	500,000 00
" mortage on property sold bearing 6 per cent. interest appropriated to the redemption of 112 bonds,	112,000 00
" Commercial Mart property,	40,000 00
" Locust Point property,	65,000 00
" wharf property at Alexandria,	12,000 00
" schooners, canal-boats, and barges,	195,750 00
" property other than mining lands, at Cumberland,	255,736 80
" property at Baltimore,	6,724 50
" property at Alexandria,	1,332 00
" bills receivable, and other available assets,	212,854 86
" coal on hand,	21,575 25
" cash on hand,	15,288 95
	$5,938,262 36
By balance,	$266,075 94

REPORT ON THE LANDS OF THE BROAD TOP IMPROVEMENT COMPANY.

Although it is near four years since the purchase of our lands, we have not presented a report of our property, or the operations of the Company, until the present time, in consequence of the non-completion of the railroad; but as the branch road on Shoup's Run will be finished to our opening below Broad Top City, during the next sixty days, when that mine will be in active operation, we have deemed it advisable to present to the stockholders at this time the accompanying report.

The lands owned by our Company comprise the largest body of coal lands owned by any one company in our State, numbering 1,654 acres and 80 perches, and we hazard nothing in saying, that they are of greater intrinsic value than any other single body of lands in the State of Pennsylvania.

Since the purchase of our lands (in 1853,) the Huntingdon and Broad Top Railroad has been commenced and finished, at a cost of about one million two hundred thousand dollars, and this large outlay of capital, (which was necessary for the development of the Broad Top coal field,) has, of course, largely enhanced the value of the lands of our Company, and that value will be constantly increasing as fast as the branches of this road shall be extended to reach the various portions of our large estate.

It is true the best evidence we can have of the value of any property is in the income it produces, but that evidence of the value of our lands we could not have, until an avenue had been provided by which its immense mineral wealth could be developed and conveyed to market. To construct this avenue or road has been (as the most of our stockholders well know) a very tedious and expensive work, but the main stem of that work is finished, and the road has been in operation during the last year. The branch up Shoup's Run (partly constructed by our Company), will reach our opening in the Cook Vein in about sixty days, and the present year our stockholders will begin to realize the more satisfactory evidence of the value of their investments in an income received from them. What that income may eventually amount to we shall not undertake to determine. We only know that after the branches of the Huntingdon and Broad Top Mountain Railroad are entirely finished, and our immense property

reached at all points by those branches, we can have collieries enough to produce an annual revenue or dividend of more than 25 per cent. on our capital stock; or as Mr. Strong says in his letter hereto annexed, "the income of the Company can be rendered larger than that of any coal estate in the commonwealth." The next, and a very important question to consider is, *will there be a demand or market for the large amount of coal which will eventually be produced from the Broad Top Region?* That the demand will be equal to any supply which can be brought to market we think we can satisfactorily prove: In the first place it must be borne in mind that our coal is *semi-bituminous*, or as Professor Rogers calls it in his State Report, *semi-Anthracite;* and while it can be used for many purposes for which anthracite is used, yet it will not come in direct competition with that coal, as its general use will be for purposes for which the Anthracite is not well adapted, such as sea steamers and steamboats of all kinds, machine shops, locomotives, rolling mills, puddling furnaces, and smithing purposes, besides the quantity that will be used for domestic purposes by those who prefer it to the hard coal as a fuel. It is of course impossible to estimate to any certainty the quantity which will be required in future for the above purposes, we can only give you facts which are before us, and upon which we base our opinion that the demand will, for many years to come, equal any supply that can be brought to market. Look for a moment at only one interest in our country which has heretofore not drawn at all upon our coal fields for fuel, except to a limited extent, but which is now beginning its use, and will in a very short time be one of the largest consumers of coal in our country! we allude to the railroad interest, an interest which has invested in it more capital than any other one interest in our country. A writer in "Hunt's Merchant's Magazine," in an article on this subject, truly says, "the millions upon millions of American capital and American credit invested in railroad enterprises in the United States, when but slightly benefited by any improved system of management, will exhibit a vast aggregate of gain to the wealth and pecuniary strength of our nation." This is most true, and can it be supposed for a moment that the managers of this immense interest will fail to "benefit" that interest by reducing its heaviest item of expense (which is fuel) 50 per cent. when it is in their power to do it? There can be but one answer to this question, and that answer is now being practically given by various railroads throughout the country in their experiments on this subject, all of which show a saving of expense of from forty to eighty per cent. as between wood and coal; and we venture the prediction that in less than three years time, coal will supersede wood as fuel on more than four-fifths of all the railroads in our country where coal can be obtained.

The question then arises, what amount of fuel is required to supply this gigantic interest? We shall not attempt to form an estimate for the entire length of railroads in our country, but shall speak only of the railroads in those States north and east, which must be supplied mainly from Pennsylvania; an approximate estimate of the quantity of coal that will be required to supply this new demand, may be made from the facts taken from a New York paper: FUEL.—Talking of fuel, the quantity of wood consumed by our railroads, is so immense that it makes one wonder as to where it comes from. The Hudson River Railroad used up, last year, forty thousand cords—nearly one thousand cords per week! The following table shows the consumption and cost of fuel on some of our leading roads:

	Length in miles.	Cost of Fuel.
New York Central	300	$400,518
New York and Erie	400	510,130
Hudson River,	144	191,130
New York and Harlem,	130	129,341
New York and New Haven,	61	115,430
	1035	$1,346,549

Here are five railroads, the length of the whole being 1,035 miles, that paid in

1854, $1,346,549 for wood! showing an average cost on those roads of over *thirteen hundred dollars* per mile for the year! The following was the length of railroads in the States named, on the 1st of January, of the present year:

RAILROADS IN THE UNITED STATES 1ST JANUARY, 1856 AND 1857.

(*From the Annual Supplement to "Dinnsmore's American Railroad and Steam Navigation Guide."*)

STATES.	Mileage. Jan'ry 1, 1856.	Mileage. Jan'ry 1, 1857.	Increase.
Maine,	422.2	422.2	0.0
N. Hampshire,	645.5	645.5	0.0
Vermont,	515.6	515.6	0.0
Massachusetts,	1,207.1	1,266.6	78.5
Rhode Island,	79.4	85.4	7.0
Connecticut,	596.2	600.9	4.7
New York,	2,668.2	2,702.9	34.7
New Jersey,	448.3	472 3	24.0
Pennsylvania,	1,727.8	2,164.1	426.3
Delaware,	84.0	119.0	35.0

showing that in those States we have now over, 8,994, or within a fraction of 9,000 miles of railroad in active operation; the fuel for these roads at the same cost per mile as paid in 1854 by the five roads before mentioned, would amount to the enormous sum of *eleven millions seven hundred thousand dollars annually!!!* But suppose that by the use of coal these roads should reduce the cost of their fuel one-half, it would yet take the large amount of near six millions of dollars to pay the cost of their fuel, and we repeat again that the time is now at hand when they must begin the use of coal on their roads, for our forests are so rapidly disappearing before the immense demands which have been made upon them, that "the primitive sources of supply cannot much longer be looked to for fuel."

Thirty years since, coal was scarcely known in dwelling houses. Twenty years since, it had just *begun* to be used in houses. Ten years since it was scarcely used in steamboats at all. It was looked upon as an impracticable thing for steamboats to use coal. Now all steamboats use it that can get it. The same thing will take place in regard to locomotives. They *will* be adapted to coal; and the *saving* being added to the profits, will increase the dividends of the stockholders just so much.

D. C. McCollum, Esq., Superintendent of the New York and Erie Railroad, in his report for the month of July, 1856, on the expenses of the road, says—"The greatest item of expense is fuel, one cord being required for every $27\frac{67}{100}$ miles, the cost of which is $\$3\frac{60}{100}$. *Our railroads will soon be compelled to use coal as a fuel.* No less than 10,032 cords were consumed on this railroad in July, in running 287,587 miles. The number of cords of wood consumed per annum at this rate, amounts to 120,384 cords, *or a pile* 182 *miles long, four feet high and four feet broad.* Our forests must soon go down before such fiery dragons as our railroads, which, with but few exceptions, use wood for fuel exclusively." This is the testimony of the superintendent of the New York and Erie Road to its managers last year, and we could cite much other testimony of the same character.

Professor Benjamin Silliman, of Yale college, has recently written an article on "Fuel for Locomotive Steam use," in which he alludes to the semi-Anthracite coals of Pennsylvania, from which we take the following extracts:

"The rapid disappearance of our forests before the axe of the pioneer, and under the constantly increasing ravages of our railways, has long since occupied the attention of railroad managers, with anxious inquiries for substitutes for their present fuel. * * * * * *

"Meanwhile the cost of wood fuel is steadily raising, and has already in many parts of the Atlantic border, reached a price beyond which it will be impracticable to use it.

* * * * * * * * * * *

"I shall not recount all the unsuccessful attempts which have been made to

adapt the locomotive fire-chamber to the combustion of hard Anthracite. This noble fuel has so far proved unadaptable to locomotive steam purposes. The great practical difficulty being in the very high temperature required for its combustion. The numerous stops of a railway train afford periods of relaxed energy of combustion, where the fire becomes deadened and the access of cold air subsequently may entirely extinguish it. The harder varieties of Anthracite require a very steady draught and constant high temperature for their combustion.

"No fuel in the world can be compared to it for the purposes for which it is especially adapted, *but it is not adapted for locomotive steam use.*

"I have had a good opportunity to observe the great extent and value of the *semi-Anthracite* coals of Pennsylvania, and their *special adaptation* for steam purposes."

The position thus assumed by Professor Silliman of *the special adaptation* of the semi-Anthracite coals for steam purposes, has been abundantly proved by the experiments made on various railroads; and there can be no doubt whatever, that our semi-Anthracite coals must supersede the use of wood entirely on the railroads of our country. And here let me state the fact, that in England and Wales, they have but 6,426 miles of railroad, and yet they consume on them over 2,000,000 tons of coal annually, while we have in the Unied States 24,476 *miles of road, being over* 400 *miles more of railroad than they have in all Europe!* And where is the fuel to come from to supply this enormous and gigantic interest, except from the coal beds of our country? And to show the enormous increase and advance of the coal interest of Pennsylvania for the last few years, let me state the fact, that from 1820, when the first ton of coal was mined, to 1856 inclusive, the total amount of coal produced and consumed, was about 66,550,000 tons, and that *in the last six years, a larger amount was mined and consumed than in the previous thirty years!* and yet the total production of our country last year was but about 12,000,000 of tons, less than one-fourth that of England, where was mined and consumed last year, over 50,000,000. And when we shall consume annually that amount, *as we shall in a very few years*, the coal beds of Pennsylvania will be called upon for more than two-thirds of the quantity necessary to supply the demand; these are not imaginary statements or estimates, but are based upon facts and statistics of this country and England, which are open to the observation and inspection of any one who will search for and examine them.

Governor Bigler in his annual message of 1853, made the following estimate: "The whole amount of Anthracite coal mined and taken to market in 1840, was 867,000 tons. In 1852, the product will reach near five millions of tons, being an increase in twelve years of six hundred per cent. This rate of augmentation up to 1870, would give the startling production of over forty millions of tons, and yielding, at the present Philadelphia prices, the sum of one hundred and eighty millions of dollars, being more than treble the present revenues of the whole United States."

In alluding again to the intrinsic value of our Broad Top Lands, we have heretofore estimated their value mainly as a coal field, but by recent explorations, discoveries have been made of more extensive and valuable deposits of iron ore underlaying and overlaying the coal, than can be found in any other coal region of our State; and it is the opinion of practical and scientific gentlemen, who have recently examined these lands, that the iron ore deposits of this region enhances the value of our property over one hundred per cent.! Upon this point we refer more particularly to the accompanying reports of Mr. Strong and Professor Whitaker. Specimens of the various ores may be seen at the office of the Company, and to which we invite the attention of our stockholders. And, I sincerely believe, with Professor Whitaker, who says: "Although it seems looking into the future, I believe that ten years of time will see the whole region teeming with furnaces and foundries, and resounding in every direction with the din of industrial pursuits;" for

the time is now at hand when the United States will manufacture her own iron, and be guilty no longer of the absurdity of sending to England or Europe for it. The coal and iron mines of England have been worked for centuries, and have been supplying us with the largest portion of our iron since the formation of our government, and they are now working their mines thousands of feet below the surface, and miles under the ocean! One of our journals in a recent article has truly said: "It is a startling fact which we quote on English authority, that the value of British iron exported to the United States in nine years, from 1847 to 1855, inclusive, amounted to 27,155,153 *pounds sterling!*" Think of it for a moment; *over one hundred and thirty-five millions of dollars* paid by this country for British iron in nine years!! And most truly has a writer depicted the absurdity of getting our supply of iron from that source—

"Descend one of these English mines where for ages the work of excavation has been going on; go down a thousand feet or more, traverse these caverns for miles under the earth until you are told the ocean is rolling above your head, and at the farthest extremities of these infernal caverns you will find men plying the pick-axe, and extracting iron ore. You will find railway tracks throughout one of these abodes of Pluto and Vulcan, leading to the shaft. Here a car is filled with ore. Inquire the destination of this car. The answer—calculated quite to astonish a citizen of the United States—would be this: It is to be sent several miles to the shaft; then to be raised up a thousand feet to the surface of the earth; then hauled to the foundry to be made into pig metal; then to the rolling mill to be converted into bars; then to the sea coast to be shipped to the other continent. After crossing the Atlantic Ocean some three thousand miles to Philadelphia, it is then to be distributed by railroad or canal throughout Pennsylvania, a State which has coal and iron enough in her own mountains to supply the world."

Now, this is the folly we have been guilty of mainly for the last quarter or half century; but, I say the absurdity will continue no longer, for we will not only manufacture our own iron, but I believe it will not be many years before we shall be exporting iron to Europe; and Professor Whitaker, who has seen and examined almost every coal field and mineral region of England, Wales and Scotland, says that he has never examined any region that possessed as many facilities and advantages for the manufacture of iron as are to be found on the property of our Company? To those of our stockholders who have never seen or examined our property, these statements may appear visionary or exaggerated. To them we can only say, go and examine for yourselves, and we feel assured you will come away satisfied that nature has been more prolific in her deposits of mineral wealth in this region than we have even estimated or stated. And who can tell the influence which these vast mineral deposits will have upon the future destiny of our country?

Report of Wm. J. Whitaker, Geologist.

In accordance with your instructions, I visited the land of your Company, situated in Huntingdon and Bedford counties, Pennsylvania, and proceed to lay before you the result of my examinations.

The estate contains nine thousand six hundred and fifty-four acres and seven perches of land, which is the choicest of the Broad Top Coal Field. It has upon it three workable veins of semi-bituminous coal—two veins of the carboniferous or black-band ore; one vein of bomb-shell ore, another of a more shelly character, and two rich veins of hematite. The position of the whole strata is such as to present every possible facility for mining operations, and that at a minimum rate of cost, as it is for the most part nearly horizontal and above the water level.

I traced the vein through Six Mile Run, Shoup's Run, Trough Creek, Broad Top, and Ray's Hill, and find them to perfectly accord in every locality. Each vein of the coal has its own peculiar features, which renders the

recognition certain wherever found. The lower or Barnet vein has under it a bed of gray fire clay, resting on a vein of bomb shell ore.

The Cook vein has a middle slate which separates the two benches of the bed, and is overlaid by gray shale, superior to which is a large vein of Black band ore. The Speer vein has also a dividing slate, which is intermingled with iron ore; it is covered by black slate, upon which rests fine sandstone shales, through which occurs shell ore in large quantities.

The iron ore overlying the Cook vein, I have traced at the Broad Top Improvement Company's opening; the Semi-Anthracite Coal Company's openings, the two openings on Trough Creek; on Six Mile Run, and in other localities; the veins of ore lying between the Cook and the Barnet, on Shoup's and on Six Mile Run; the ore below the Barnet, at Riddlesburg and Six Mile Run; the ores over the Speer vein, near the Mountain House, on Trough Creek, Ray's Hill, in two or three localities; Shoup's Run near the Hoover Place, and on Laurel Creek.

There is a vein of Mountain Limestone of two feet in thickness, traceable in many localities, which is a valuable addition to the coal and iron of the region. In addition to these, there is abundance of grindstone and millstone grit, fire clay, brick clay, and excellent building stone.

The coal is easily mined, and comes out in large square blocks, accompanied with slack or fine coal, all of which is combustible and burns admirably, either for domestic purposes or manufacture. It is free from sulphur, and will produce a sound hard coke, if proper care is taken in the burning. Its value for the generation of steam and blacksmithing are too patent to need any comment.

The amount of coal contained in your lands is inexhaustible. Taking the three veins at their mean measurements in the gangways and breasts, they present a wall of solid coal twenty feet in thickness. I base my computation of quantity on eighteen feet, (which fully compensates for all breakages on the land,) and the result is *three hundred millions of tons!*

Although the present facilities of railroad connection render the northern end of the estate the most available, the productive capacity will never be fully ascertaineduntil Six Mile Run is fully opened up, as it presents the largest exposures and facilities for mining on the whole of the veins both of coal and iron ore. (See vertical section of the strata.)

The veins at Trough Creek dip at an angle of 11°, pass under the bed of the creek, rising at the same angle on the opposite side, so that the creek forms a regular basin on this part of the estate. The Speer and the Cook veins are shown by exposures and openings in several places on Ray's Hill, and thus afford every facility for recognition.

The opportunities for the manufacture of iron *are greater than any other region of the State* with which I am acquainted, and I have travelled professionally, nearly the whole of it. There are abundant localities where the ore and the coal could be mined in the closest contact with the furnace; and although it seems looking into the future, I believe that ten years of time will see *the whole region teeming with furnaces and foundries*, and resounding in every direction with the din of industrial pursuits, and calling into action the powers of men for its development and the good of humanity.

Report of Henry K. Strong.

During the last four years, I have made repeated geological explorations of the lands on Broad Top Mountain, and am, therefore, well acquainted with the coal strata of this very valuable and interesting region.

In that part of the coal basin where most of the lands lie, which comprise the estate of the Broad Top Improvement Company, there is always one, and sometimes there are four workable beds of coal; and on a large proportion of these lands, lying as they do on an undisturbed and broad elevation which runs from north to south through the basin, will be found the two great

coal seams, the lower bed now successfully worked at Crawford and Barnet, and the celebrated Cook bed, now opened on your lands near Broad Top City.

These two coal seams will yield more than twelve thousand tons per acre, so that you have in your estate one hundred millions of tons of coal in these seams.

The Broad Top Improvement Company have a larger number of acres of real good coal lands than any other incorporated company in Pennsylvania. The quantity exceeds nine thousand acres of selected lands, which is amply sufficient for four or five large companies employing a million of dollars as capital each. This splendid estate extends from the northern limit of the Broad Top coal basin, near Broad Top City, nearly eight miles in a direction to the southern side of the basin, and is something more than four miles wide.

Only a small portion of this estate can be developed and made profitable, until the further extension of the branch railroads up the several small creeks that intersect every portion of this coal field.

One portion of this property is now reached by the Huntingdon and Broad Top Mountain Railroad at its termination on Shoup's Run, and direct avenues to market are formed by a connection with the Pennsylvania Canal, and the Pennsylvania Central Railroad. At the termination of the railroad a colliery is erected upon the Upper Main Coal, known as the celebrated Cook seam, from which a large amount of coal is expected to be sent to market the present year. As the amount of coal which can annually be sent to market from a colliery depends upon the length of gangways driven into the mine, and the number of galleries opened for the workmen, it requires time to develop its full capacity, and make it reach the highest limit of annual revenue; but as this coal seam is from six to seven feet in thickness, and nearly horizontal, gangways may be driven in every direction, so that it is rendered impossible to fix an estimate of the vast amount of coal which may annually be sent from this colliery to market, if it is worked with proper energy and effect. That it may reach by the third year one hundred and twenty thousand tons, I have no doubt, yielding an annual income of thirty thousand dollars. This, you will perceive, is from a single opening. A branch railroad is now under contract, and will be constructed up Six Mile Run, to the southwest portion of the company's property. When this is completed, a colliery can be erected fully as productive as the one on Shoup's Run. But an extension of the Shoup's Run branch through Broad Top City, and up Trough Creek, will pass eight miles through the centre of the Company's property, where a number of collieries can be located, and the income of the Company rendered larger than that of any coal estate in the commonwealth.

I have sometimes heard doubts expressed whether there would be a demand for all the coal that will be sent to market from all the coal fields in Pennsylvania. Those who doubt should be reminded of the fact that east of the Alleghany Mountains every coal field is now being developed, and the area is comparatively small. Nothing west of this great natural barrier can successfully compete with the coal fields east of it. The great coal markets are now in the east; it is the seat of manufacturing industry; and a great majority of the furnaces and rolling mills, those great consumers of coal, are in the east. Besides these there are about eighteen millions of people now living east of the Alleghany Mountains to be supplied with fuel; and as wood is fast disappearing, this eighteen millions and their increase will be obliged to use coal the consumption must, therefore, annually increase until the market will require a ton of coal annually, for every person east of the Alleghany Mountains, besides that used to propel machinery, smelt the ores and work the metals. The demand is now increasing at the rate of more than ten per cent. per annum, and will continue to increase as fast as the supply for a century to come.

In the year 1820, the first Anthracite, three hundred and sixty-five tons, was sent to market in Pennsylvania. In 1838, eighteen years afterwards, something less than seven hundred and thirty-nine thousand went to market; and in 1856, after another period of eighteen years, the amount exceeds seven millions of tons, and yet it is believed there will be a short supply. If the demand continues to increase, at the same ratio, it will amount at the end of the next eighteen years to more than fifty millions of tons, which is more than the whole amount of coal now mined in the British Isles, of every kind. It will, therefore, be seen, that the supply of coal in this country will never, for any length of time, exceed the demand.

In addition to the foregoing, in reference to the coal, recent explorations have been made, showing that an *abundance of iron ore regularly instratified with the coal exists in every part of the estate.*

IRON AND ZINC.

LAKE SUPERIOR IRON—WYANDOTTE ROLLING MILL COMPANY.

The proof of the pudding is in the eating, most emphatically in regard to iron. Whatever chemical analysis may say about purity or impurities, the test is in the wearing. We have published from time to time very remarkable facts demonstrating the tenacity and strength of iron manufactured from the Lake Superior ores. They ought to be repeated till they command the attention of all constructors who have occasion to place iron where the safety of human life depends upon it; and where mere economy is the question, it will be worth while to consider whether the better iron will not, in spite of its higher price, be the cheaper in the end. The British Admiralty proof of chain cable, studlink, whereof the round iron is 7-8 inch in diameter, is 14 tons, and the American proof of chain of the same dimension is 15 tons. From this we may appreciate the following testimony of the Engineer-in-Chief of the United States Navy, addressed to Secretary Dobbin, in regard to Lake Superior Iron:

OFFICE ENGINEER-IN-CHIEF, Sept. 12 1856.

A piece (of Lake Superior Iron) was drawn to one-half inch diameter, (round,) made into a chain link, tested in the chain-proving machine, and broke at 75 1-2 tons, or 169,120 lbs.

D. B. MARTIN, Engineer-in-Chief.

This testimony is confirmed by the experiments of Prof. Walter R. Johnson, so far as concerns the superiority of the Lake Superior iron, to all others tested by him; his specimens showing a tenacity 17.76 per cent. above Russia iron, and 53.96 above Swedes. What is far more to the point, notwithstanding the disadvantages which must necessarily attend any new manufacture, however good the raw materials, and that of iron men more than any other, the Wyandotte Works, started on this ore, have produced iron unequalled in its strength and wearing. The testimony on this point of practical iron workers is unanimous and unreserved.

The history of the Wyandotte Works well illustrates the growth, and presages the destiny of the American Iron Manufacture. In the winter of 1854–'5, the site was a wilderness. It is in Michigan, on the banks of the Detroit River below the city of Detroit, and in immediate contact with deep water for the Lake Navigation. It has connection by the Detroit and Toledo Railway with all the great lines of railway running eastward and westward. At the date above mentioned, a purchase was made of 2,260 acres of unpopulated territory at that spot, which now sustains a village of about 800 houses inhabited

by 3,000 souls. Four hundred building lots have been sold, and building is rapidly progressing.

The Eureka Company has there a blast furnace which produces 3,000 tons of pig iron per annum—made entirely with charcol. This Company owns the Eureka Iron Mine, the nearest to Lake Superior of those hitherto worked, we believe, and about two and a half miles from Marquette.

The Wyandotte Rolling Mill Company have in operation a mill for rolling Merchant Bar Iron, built at an expense of $75,000, which employs 100 men and produces 3,000 tons of iron per annum. They are also largely engaged in manufacturing railway and ship spikes and boiler rivets, for which their iron is admirably adapted. They also make car-axles of any desired pattern. The same Company have just completed another mill for re-rolling and manufacturing Railway Bars at an expense of $120,000. The dimensions of the building are 140 by 200 feet. It is now worked by two low pressure engines of 100 horse power each, gives employment to 200 men, and produces 12,000 tons of rails per annum, all made with charcoal. The engines and machinery are constructed with a view to double the production if necessary. We copy from the Detroit *Free Press* of May 26th, the following account of some new and improved machinery to be introduced into this and a similar establishment now building in Chicago.

Wyandotte Rolling mills—Capt. Ward's Chicago Rolling Mills.

We had our attention casually directed, a day or two since, to the new machinery which is being constructed at the extensive iron works of Messrs. Jackson & Wiley, in this city, for these two establishments. The new mill lately put up at Wyandotte, for the re-rolling of railroad iron, is now driven by a double cylinder low pressure engine. This having been found to work badly in connection with the high pressure boilers used, will be taken out next August, and its place supplied by two new high pressure engines, of great power, now being built by Messrs. Jackson & Wiley. They are constructing at the same time, two more of the same kind for Capt. Ward's works in Chicago, together with the full complement of machinery necessary to put them in operation. This is of the same kind as that now in use at the Wyandotte Mills, which was constructed at the same manufactory, and has given the best of satisfaction in its operation, aside from the working of the old engines. The expense of the removal of these, and the substitution of the new ones, is estimated at $10,000.

The new engines are peculiar in their construction, and intended to be particularly adapted to the purpose for which they are designed. The cylinders are of much the same shape as a locomotive cylinder, having a bore of thirty inches, and a stroke of but twenty-eight inches, thus reducing the crank to the very short length of fourteen inches. The slide valves are of uncommonly large dimensions, allowing of commodious apertures for the admission and exhaustion of steam, from the cylinders. The enormous pressure of steam, consequent upon the large surface presented by these valves, is remedied by a contrivance of great ingenuity, by which the steam is made to counteract its own force, and relieve the valve of some forty or fifty tons' pressure, which would otherwise render its working by means of a lifting bar in the hands of the engineer, impossible. The large bore and short stroke of these engines are intended to do away with the gearing now used, as the engines will be run up to a speed of sixty revolutions a minute, and the rolls attached directly to the main shaft of the engine.

The fly-wheels, four in number, are of themselves heavy pieces of iron work, being twenty feet in diameter, and weighing twenty tons each. They are cast in separate pieces, and fitted together so nicely with the planer and cold chisel, that, when set up, they run with perfect precision, scarcely the slightest variation being observable in their motion. One of the same wheels is now in operation at Wyandotte. The whole cost of the machinery being constructed for these two mills will probably exceed $50,000. Messrs. Jackson

& Wiley have over a hundred men employed, and are pushing it forward to completion as fast as possible.

The ores of Lake Superior have been analyzed by the best chemists both in this country and in France, and have in no instance, we believe, been found to contain any trace of sulphur, phosphorus or arsenic. To this is attributed the excellent quality of the iron and its remarkable fitness for steel. The design of the Sharon Company is to devote the whole of their iron to the manufacture of steel. The Lake Superior charcoal pig is beginning to be widely appreciated at the West for car-wheels, and in the lake navigation the wrought iron has superseded all others for chain cables. These facts, taken in connection with the vast forests which still cover the north-west, and the mineral coal which underlies so large a part of the great Mississippi Valley, show that in reality the question of the home iron manufacture is settled. For all the iron used in building ships and steam boilers, and for nearly if not quite all used in building railway bridges and rolling stock, price is nothing, but quality every thing. After the demonstration in favor of Lake Superior iron, it is hardly better than a crime to use the ordinary imported iron where human life depends upon its soundness and tenacity. Yet the United States Government, with its absurd rule of letting its work to the lowest bidder, and treating every thing ferruginous as iron, goes on building and fitting out its navy with iron that degrades and mortifies every feeling of national pride. It spends a million or two to astonish Europe with the work of our immortal Steers, and puts such miserable iron into her machinery, that the Niagara, with her theoretical power of out-stripping any thing that swims, mus the seventeen days *snailing* across the Atlantic! What a stupid Government! When we have iron that beats all the rest of the world's as much as our great cataract does theirs, we don't put a pound of it in our crack ship which rejoices in the cataract's name, because a pound of it would cost *four and a half or five cents;* while "iron" can be bought for *three cents!* We hear a great deal about "raw material,"—we should like to know what material in the world is rawer than a government that builds national vessels in this fashion. It is about time to have American sentiment as well as American iron, and a sentiment that shall no more allow the government or the railway companies to substitute inferior for Superior iron in steam ships and locomotives, than it would now allow them to build either of lead or of type metal.—*Boston Railway Times.*

HOMOGENEOUS IRON.

The subject of improving the quality of Iron, is one of the greatest importance. A paper was read before the Liverpool Polytechnic society, by Mr. Maxwell Scott, on a method of preparing iron so as to augment its soundness, and all those qualities, which render it valuable for manufacturing and engineering purposes; the metal so prepared has been denominated, from the name of the inventor, "Howell's Homogeneous Metal."

"In introducing the subject of this evening's paper to your notice, I will state, in the first place, how it occurred to Mr. Howell to try whether it was not possible to make metal out of iron to be of increased strength and to be perfectly homogeneous, or of one texture throughout, so that when we saw the fracture at the outside of the bar or plate, as the case may be, we should be certain that it was of the same texture throughout, or perfectly homogeneous. The firm of which he is a partner had the misfortune, some years since, to have a boiler burst on their premises. On examining the iron of which it was made, they found, that although the outward appearance of the iron showed that it was perfectly sound, yet there were portions of it that were not perfectly laminated, and we can easily account for it, when we consider the method adopted in the manufacture of iron.—It is, as most of you are aware,

melted from ore into pigs; these are afterwards broken up, and placed in a puddling furnace and made into puddle-balls, or blooms, which are rolled and made into short bars or lumps of iron. When a large plate is required, several of these are welded together and then rolled out. Should any of these be imperfectly welded, such imperfection will continue in the plate that is made from it. Now, in the manufacture of the homogeneous metal, the iron of which it is made is the best charcoal iron cut into pieces, and put into a crucible or ordinary melting-pot, with ingredients that make malleable iron quite fluid, and at the same time free it from all foreign matters, leaving the iron pure, or one homogeneous mass, and perfectly free from blister or unsound parts. The iron, as I stated, is melted in pots, and when we require a large ingot to roll into, say a boiler plate, it requires several of these pots to be melted; and care is always taken, that before the contents of one pot is emptied another is commenced pouring, and so on until the ingot is filled. You will see, by this method, we are almost certain to have the mass perfectly sound. Having thus got the ingot, it is rolled out in the usual manner, and made into plates of any required thickness. From what I have stated of the process of the manufacture, you will see that we can make it into bars, plates, or of any required form. Before stating the several uses to which the homogeneous metal is applicable, and to which it has been applied, I will give the result of the experments made to show its power of transmitting heat. It has been tried in several ways, but the table, as exhibited, shows the relative power as possessed by it, and copper, and iron."

Mr. Scott here referred to a diagram, showing the length of time required to evaporate a certain quantity of water from a cup made of the new metal, over a gas flame, compared with one of iron or copper. In an iron cup 1-4 inch thick, 7 ounces of water were evaporated in 32 1-2 minutes; in an iron cup 1-8 inch thick, the time required was 25 1-2 minutes; in a steel cup, 1-8 inch thick, 19 1-2 minutes; in a copper cup, 1-8 inch thick, 6 ounces were evaporated in 24 1-4 minutes. He continued:

"It has also been tried to show its strength as compared with iron, and, from the numerous experiments tried, it is ascertained, taking the mean of several, that the tensile strength is 35 tons per square inch, or nearly double that of wrought-iron.

An experiment was made on a boiler by an eminent firm in Cornwall. The boiler consisted of one plate of homogeneous metal 1-8 inch thick, with wrought-iron ends 1-2 inch thick, stayed with iron stays; when made, it measured 3 feet long by 2 feet 6 inches diameter, and was tested by hydraulic pressure of 560 lb. per square inch, when the ends gave way, and the iron was completely destroyed, not having an inch of sound plate in it, while the cylinder, or barrel of the boiler, remained perfect, and the only difference found in the cylinder was an increase in the diameter of 1-4 inch, equal to 3-4 of an inch in the length of the plate, without any signs of breaking; a most surprising result, considering the relative thickness of the ends and barrel of the boiler.

There have been several boilers made of the homogeneous metal. One was tried by a firm in London, who made it for the patentees; but they found the advantages possessed by it so great, that they immediately purchased it. It is a twenty-horse boiler, and the parties who have it state that they save in fuel from £2 to £3 per week; and it has been ascertained from this and several other boilers, that the saving in fuel amounts to more than 15 per cent.

I will now state several of the uses for which the metal is being applied. It is used for tubes, for locomotives and other tubular boilers. The tubes are remarkably thin, and at the same time of immense strength. They also possess the great power of transmitting heat rapidly; they are, at the same time, easily fitted to the tube plate, being nearly equal in malleability to copper, as you will see by the specimen before me. Many persons who have seen this

specimen would not otherwise have believed it possible that the metal possessed such a property. The other specimens have been bent and hammered cold, and do not exhibit the slightest flaw or appearance of fracture. It is also being used for the manufacture of hollow axles for locomotives; and you will, I think, agree with me that it is desirable that these axles should be made of the best possible materials, when we consider the lamentable loss of life that occurs through the breaking of them; as, for instance, that frightful accident that occurred in America, owing to an axle breaking. I have heard it stated that solid axles are liable to break, owing to their unequal temperature, which you can easily conceive when you consider the immense speed they rush through the air, causing thereby the outer surface to be suddenly chilled, and thus causing unequal contraction and expansion; and, after a certain period, it may so deteriorate the quality of the iron, that it may be the cause of those serious accidents that do sometimes occur. The hollow axles are not liable to this objection, as they have the current of air both inside and out; and when they are made of the metal I am speaking about, I think they will be as perfect as it is possible to make them.

There is also another subject, and one of great importance, which I think, if carried out, would realize a very good return to any person who would undertake it—it is the use of the above metal for building vessels; and as I have already stated it possesses double the strength of wrought-iron, we could build a vessel of nearly one half the weight of an iron one, and still be quite as strong if not stronger.

I give an example: I take an iron vessel of 1,600 tons burden, and 300 horse-power:

The iron hull of which weighs	700 tons.
The boiler weighs	80 tons.
Total weight	780 tons

If built of homogeneous metal she would weigh 390 (say 400) tons, leaving a balance of 380 tons in its favor, besides which, the boiler being made of the metal, there would not only be a saving in fuel, but in the quantity she would require to carry. Taking an average voyage, say to New York, at 12 1-2 days, she would require 1 1-2 tons of coal per hour, or 36 tons per day, giving on the voyage a total of 450 tons. Now, if we deduct 15 per cent., it leaves 385 tons, thus giving a gain of 65 tons.

Now suppose two vessels of similar make, one of iron, the other of homogeneous metal, both loaded to the same depth, we shall have additional freights carried by the latter one of 445 tons, being 380 tons in hull of vessel and 65 tons of coal, which would stand thus:

445 tons, at £3 per ton, gives	£1,335
65 tons coal, say £1 per ton	65
	£1,400

Supposing them to be full each voyage, she would make a profit over and above the other vessel of £2,800,—a very considerable amount.

There would no doubt be a difference in the first cost of the vessels. The iron one would cost say £50,000; if made of homogeneous metal the first cost would be about £55,000, or an addition of 10 per cent., against which we have a clear gain each voyage of £2,800, which is certainly a very great percentage on the additional cost of £5,000.

There has been a deal said and written about swift boats to carry the mails between Holyhead and Kingstown, and I think it would be to the interest and benefit of the parties concerned if they were to institute an inquiry into the above subject, as it is self-evident that if we can build a vessel of equal strength at one-half the weight, she would, consequently, draw less water, and with the same amount of power we should gain an additional increase of speed, and a reduced consumption of fuel, thus saving in weight of vessel and of coals required to be carried, as I think you will easily see when you consider the details I have already gone into. I have no doubt the result would astonish the projectors, and make a revolution in ocean steam navigation.

I must again revert to the gain in the consumption of fuel caused by the use of the homogeneous metal, especially when taken into consideration with the auxiliary steam vessels trading to Australia. Taking the average use of the engine at one-third of the voyage, say twenty-one days, we should gain three days, which would make the time we could use them, with the same quantity of fuel, equal to twenty-four days, besides which there would be a gain of one-half the weight of the boiler. The time we could use the engines beyond that formerly done of three days would be a great gain, as we have instances of a few hours making a difference of many days, sometimes weeks, in a voyage. In a distance of a few miles between two vessels sailing, one may have just passed the point where a storm commences, and so have sailed on her journey, while the other may have caught the full effects of the storm, and been detained days, if not weeks, as was stated to me by a member of one of the greatest steamship companies in the world. We were speaking about the speed of the vessels crossing the Atlantic, and he said there could be no comparison unless started side by side; and he related instances of vessels sailing from here to Glasgow, one starting a few hours before the other, the first having passed when a storm commenced, the other just caught its full effects, and so made a difference of double the length of time occupied in the voyage of the vessel which started first; and we shall be able to judge what a difference three days' steaming might make in a voyage to Australia, especially when used to take the vessel out when becalmed, as they often are when crossing the line, and so placing them in a position to pursue their voyage. I might bring forward many more illustrations to show the advantage of a gain of 15 per cent. in the consumption of fuel; but I think the above instance will suffice, as many cases will occur to your own recollection where great gain might be experienced, as for instance the Halifax line, where a gain of 15 per cent. upon the fuel consumed by their vessels, would amount to several thousands in the course of a year.

There is scarcely any machinery or matter in which wrought-iron forms the most important part, but we could claim for the homogeneous metal increased advantages; as, for example, the introduction of tubing of the metal for shafts for mills and driving machinery. As its great stiffness and comparative small weight, in comparison with wrought-iron, is causing it to be used, and will eventually lead to its adoption, especially in our large cotton mills, where there is such an amount of shafting kept in revolution, there would be great saving in the wear and tear of the brasses and other parts of the machinery, and also on the power requisite for keeping it in motion. I mention this as an example in point. There is also another subject which I though would have been brought forward this evening, viz., the subject of life-boats. How far the extreme lightness of which one could be made would be essential to their power of living in such heavy seas as they have to contend with, I am not prepared to say. I merely throw the hint out, as we shall be better able to judge of the matter when it comes before us.

The patentees expect to be able to make the metal to be able to withstand the action of salt water, and an experiment is being tried for that purpose in the neighborhood of Bristol, the result of which I will at some future time communicate to the society. I might draw a comparison as to the advantages to be derived by its adoption in the making of masts, yards, &c., but think sufficient has been said to enable comparison to be drawn by any one conversant with machinery, to the many great advantages likely to accrue from its adoption.

The age in which we live is famous for the numerous inventions and appliances to facilitate labor, so that we of the present generation live in comparison three to four times as long, if not in years, at least in the quantity of labor we accomplish, to those of our forefathers, of which we have numerous instances in the town of Liverpool; and first I would notice the hydraulic cranes as used at our dock warehouses, where the unloading of vessels is accomplished in an incredibly small space of time, thereby enabling us to unload at least six

times the number of vessels that we could by manual labor, the method formerly used. We have steam cranes and winches to accomplish the same end. Then, again, we have our railway to the margin of the docks to keep with these, and enable us to take away those immense quantities of goods, and transport them at once to the manufacturer or the consumer; and, as if that were not rapid enough, we have the electric telegraph to give notice that these goods are either on their way or coming. These all tend to lengthen time, and no doubt that these are immense boons to society, and their originators deserve the best thanks of the community for their endeavors; and I think if only one-half of the advantages I have stated does accrue from the adoption of the metal I have the honor of bringing before you this evening, it will add another to those numerous inventions which have for their end the saving of time, labor, and money, which we of the present generation have so much at heart."

Some samples of iron prepared by the new process, and others of the best Lowmoor qualities, were exhibited, affording striking proofs of the superior ductility and tenacity of the former.

LAKE SUPERIOR IRON MINES.

During the past week we took occasion to visit the iron mines of the Cleveland and Sharon companies, and, in accordance with our expectation, found them in capital working order. The new opening at the Cleveland mountain, of which we have heretofore spoken, is in many respects far superior to the old one, the ore being less intermixed with foreign substance. It now presents a perpendicular wall varying from 40 to 60 feet in height, and 200 feet long, leaving a large portion of the hill yet uncovered. On the face of this wall only one small vein of any impure or rocky ore is to be seen, and this has diminished materially as the excavation has been continued, so that it is quite probable that on further working it will disappear altogether. The ore is remarkably rich, and what is not a little singular is very brittle, breaking up as easily as common ore that has been roasted; about half of the present opening appears to be full of fine cracks and seams, and the ore is easily displaced with a pick or bar, other portions being as solid to all appearance as the old opening. So far no signs of jasper have been discovered, the ore being clear and pure, with the exception of the distinct vein of rock which we before mentioned, and this being small, will offer but a slight impediment to the general working. The amount of ore taken out at this point up to the present time is not less than 3,000 tons, and the mine is in such shape that, with a large force, nearly this amount could be taken out weekly. At the old opening there is about 2,000 tons ready for removal, which, with the amount given above and what is already on the dock, gives the company a stock of 8,000 tons to commence the season with. The plan of operation in the mine is excellent and economical—the ore being taken off down to a level with the hill, a railway is laid alongside, and as the mine is worked in the track is easily moved towards it, rendering the labor of loading the cars comparatively short and easy. The grading for the branch track to this mine is nearly completed, and being only about a quarter of a mile from the main track will probably be laid in a few days. It is but a simple act of justice to the management of this mine, to note the amount of labor performed since the 1st of December last. In addition to the ore mentioned as being taken out of the new opening, an equally large amount of rubbish was removed from the surface, and the whole ground in and about the mine fully prepared for the summer's operation with a force of only six or eight men, and this too in the dead of winter.

As our time was somewhat limited, we did not stop long at the Jackson mine, but a casual glance revealed some improvements of importance.—Preparations are being made to lay a new track directly into the mine, somewhat similar to the one at the Cleveland mountain, which, with a new blacksmith shop and dwelling house, were all the changes we noticed since our last visit.

The situation of the mine is not materially changed from our remarks of three weeks since, it still presenting a broad solid face of pure ore. On Wednesday the railway was so far clear of snow that some three or four teams, belonging to both companies, came through with a load of ore, and they are now making their regular trips the same as last season. The railway does not seem to have been injured but a very little by the winter storms, there being no place, we believe, where it is impassable, and it will probably remain good until the locomotive road is ready, when we shall look for almost a deluge of ore.—*Lake Superior Journal.*

WAGES AT THE IRON WORKS IN WALES.

A correspondent of the Pottsville *Miner's Journal*, who is now in England, communicates the following schedule of wages, which may be interesting to our readers:

Wages at the Nant-y-Glo Iron Works, Sept., 1855.

"Rail Rollers,"	$90 to $100 per month
"Roughing Rollers,"	50 to 60 "
"Slabbin Rollers,"	60 to 65 "
"Puddle Rollers,"	30 to 35 "
Women—'tying up tops and bottoms,'	10 "
Boys—"Hookers,"	8 to 10 "
"Raising doors,"	3 "
"Sweeps,"	2 50 "

ROLLING MILL.—*Wages at the Rhymney Iron Works.*

Puddlers.	*per ton.*		*per month.*
For "metal,"	$1 56	equivalent to about	$40
"Pig and Metal,"	1 68	" " "	45
Boilers.			
"First heating,"	36	" " "	50 to 55
"Second heating,"	40	" " "	65 to 70
Rollers.			
"Slabbin,"	32	" " "	50 to 55
"Roughing down,"		" " "	55 to 60
"Finishing,"	52	" " "	90 to 95
"Squeezers,"			25
"Cinder Cleaners,"			14
"Weighers,"			20
"Laborers,"			16
Boys,			10
"Bundle Pilers,"—women and girls,			8 to 9
Furnace.			
"Casters,"			40 to 46
"Metal breakers,"			26
"Refiners,"			50 to 55

An advance of ten per cent. was about to take place on the above rates, and then they will be as high as ever before known in Wales.

JOURNAL OF GOLD MINING OPERATIONS.

THE CALIFORNIA GOLD PRODUCT.

A very interesting question has just been started in reference to the gold of California. It is whether the mines are giving out. The export of the precious metal is obviously diminishing. During the quarter ending March 30th, 1857, the total amount shipped from San Francisco was $10,258,548. This was $172,402 less than the total of the corresponding period last year. A decrease covering a month only might be explained satisfactorily; but a period of three months, showing a deficiency, would argue some general change as beginning. Many of our contemporaries on this side of the Continent have regarded the decrease in that light. They even go further, and

express considerable alarm at the occurrence. That this was not a mere newspaper opinion is susceptible of demonstration. Brokers, speculators, financiers and business men engaged in great operations, watch all such things very closely. They know far better than newspaper editors do the important part which California gold has enacted in the recent history of trade in the United States. It is the universal belief that our sudden and astonishing growth and prosperity are attributable to the steady influx of abundance of gold from California. An Atlantic correspondent of a San Francisco commercial paper, writing under a recent date, made use of the following language:

"Some alarm has been manifested in business circles by the suggestion that California gold is giving out, and a terrific revolution in our paper credit system must follow, and the inflated prices of real estate every where undergo a collapse."

We are not of the number of panic-mongers. It is much more to our taste to anticipate success than failure. Moreover, prophets of woe are seldom of any benefit to a community. Hence, we undertake with extreme reluctance, the task of checking progress, even when the career is too headlong and precipitate. But it is the office of a wise counsellor to speak the truth at all times, however unpalatable it may seem. Commercial operations change in their nature with the varying aspect of affairs. When one of these great alterations is impending, it is worse than idle to attempt concealment. It must be studied carefully and prepared for, or else a revulsion is certain.

Now, in the case before us, it is an interesting query whether the exports of California gold must continue to diminish. The *San Francisco Herald* thinks that such a result is inevitable. And it gives some reasons for it which are deserving of consideration. It says:

"It is our deliberate opinion, that the exportation of gold this year will fall considerably below that of any preceding year since the settlement of the country by the Americans; and the cause is not to be found in any real or supposed 'giving out of the mines,' as it is termed in the Eastern States, but to the gradual development of our agricultural and manufacturing resources."

Upon this topic, the development of agriculture and manufactures, the *Herald* proceeds to give at length some information. But for our purposes it may be condensed into the following leading statements:—1st. California raises more flour, barley, hay, and oats than is necessary for the use of its people, and has done so for several years past. From this the *Herald* estimates a reduction of ten or twelve millions of dollars yearly, in the annual pments of gold, to pay for those articles, which were heretofore imported. 2d. Meat is extensively cured in Oregon, and large quantities are sent to California. In a short time it is expected that all the needful supplies of the article will be derived from Oregon. 3d. A recent advance in the price of leather has given such an impetus to the trade in hides, that large cargoes of them have been exported from California. What this trade may become it is only possible to estimate by remembering that, in former years, the entire foreign commerce of California was in hides. 4th. Butter and cheese are now made there so largely that imported articles of that kind are now almost entirely driven from the market. 5th. Native wine is now so extensively manufactured as to supersede, in a great measure, the imported brands. California vineyards are now capable of producing more than twenty millions of pounds of grapes annually. 6th. The fabrication of mining machinery is now carried on extensively in San Francisco and other cities. 7th. The refining of sugar, the making of paper, and a great variety of other branches of industry, have been introduced.

All these efforts in the way of home industry tend to make California somewhat of a self-sustaining community, and to diminish the importations from the Atlantic States. It was to pay for these that the gold was sent away as fast as it reached San Francisco. The balance of trade was heavily against

California. Such odd matters of import as butter serve to show us to what an extent that colony depended upon the rest of the world for all articles of necessary use. The *San Francisco Herald* felicitates itself over the fact that the State now supplies its own candles, brooms, furniture, etc.

It cannot be denied that in this there is much force. That the gold export does fall off appears by the official reports. And here is a valid reason for it. But how far that diminution can extend under the influence of such a cause, is another question. Here in the Atlantic States, we manufacture hundreds of articles more than the variety made in California, and our industry is perpetually extending into new branches. Yet our imports increase instead of falling off, and the balance of trade steadily remains against us. This is explained by the fact that, though we make these articles, they have to enter into competition with a cheaper fabric from Europe, or contend against long-established prejudices. Now, is not California industry in the same category? We think it is. Here, where labor, fuel, and every thing else may be had so much cheaper than in California, and where education, capital, and training enable us to command superior skill and machinery, we can turn out all kinds of articles better and at less cost than they can in California. Hence not only must the industry of the Pacific State be largely increased, but it must have a struggle for the possession of its own markets.

Again, the population there increases so rapidly, that the demand for all kinds of goods must keep constantly ahead of the domestic supply. This is evident from the statistics brought by the last mail. It appears that the State has already over half a million of inhabitants. This is a much greater increase than any body could have supposed. And yet the sexes are very far from being equalized. Two years ago it was calculated that the adult male population of the State would, in an ordinary condition of society, represent a population of nearly a million of souls. Of late the emigration to California has not been large, and, as we have several times shown, the gain by that source exhibits a large excess of females. Hence, the increase of California is mainly attributable to the process of equalization. A continuance of it would, according to our theory, give the State a million of inhabitants. The manufacturing industry of California would have to grow very fast to be able to supply such a number as that with articles of merchandise. In the drygoods and hardware trades all articles of consumption must be imported, as there are now no factories on the Pacific to make them. The great staple articles of the grocery trade, sugar, tea, coffee, molasses, oil, rice, etc., must continue to be imported. And the more California increases in population, wealth and prosperity, the more demand will she make for these. Such is the case here, and it must be the same on the Pacific. In fact, we look for an improved state of society there as likely to be of great benefit to commerce.

From this view of the case, it follows that the decline in the exportation of gold can only be temporary or to a limited extent, if it be true, as the *Herald* alleges, that the mines are yielding more instead of less than heretofore.—*Phila. North American.*

JOURNAL OF COPPER MINING OPERATIONS.

The following items of mining intelligence are extracted from the *Lake Superior Miner* of May 30:

The *National*, at a late visit, was showing more copper than we have ever before seen in the mine. The masses are still thinner than those of the Minnesota location, but the vein is widening in the eastern part of the mine, and

the copper branches more into the lode, and even somewhat into the conglomerate, and does not appear to be confined to the thin sheets lying upon one side of the lode, as was formerly the case in this mine. They will probably be able to increase their monthly product considerably during the summer.

Our last quotations show that Minnesota stock was selling at $175. We took occasion to predict some time ago, that it would rise to $200 per share, and have no doubt that it will reach, and probably surpass that figure. There are good reasons for this supposition. There is near a million dollars' worth of copper in sight in the mine. They will get out 2,100 tons this year, of extraordinary purity; 75 per cent. is within bound for it, and it would thus be worth $835,000. The number of men and consequent expenses of the mine are much increased this year, but the latter item ought to be within $300,000 —leaving a profit of $535,000. Why then may not half a million of dollars be divided among stockholders at $25 per share?

We have been into the mine quite often of late, and besides the incredible amount of mineral now to be seen in the older part of the mine, there are two features which give us firm assurance for the future of the Minnesota. Their most eastern workings, away beyond the No. 6 shaft, are full of copper, and quantities of the lode are ready to be taken down. Their deepest shaft, also down to the LXX. fathom level, goes down by the side of what appear to be great strings of masses. Hence their new ground is promising splendidly, both sinking and going east.

In the eastern part of the Rockland mine, in the X level, they are working in most excellent ground. A chain of masses some thirty or forty long is going up west toward the adit, from which they have taken, and are still getting, a great deal of copper. They are extending the adit level westward toward No. 2 shaft, and were lately in quite promising ground. They were also about taking down vein from a level above the adit where copper has shown for some time. The openings are going on with vigor underground. The stamp mill and railroad are in fine operation.

The prospects of the Superior mine are brightening very sensibly. They have connected shaft No. 1 with the adit, and are driving for connection with No. 2, which was sunk to the proper depth during the winter. The indications now go to show that they will probably reach masses in the great conglomerate lode before the Rockland mine. In fact there is good reason to suppose that they are in the immediate vicinity of them. Several beautiful things are appearing near the western end of the bluff. Some three new copper-bearing veins have been uncovered, and a remarkable crossing, deeply marked with ancient pits. In two of these lumps of pure copper have been found, surrounded by green carbonate—some of them of a pound or more weight. Only two or three of the ancient pits have been scraped out, but they show remarkably well. There is abundant reason for an upward movement in the rates of shares in this mine.

The Flint Steel have connected as we gave notice in our last, and have now quite a mine open on the south lode. The depth of the shaft near to the end of the bluff is about 200 feet to the adit level. This level extends more than 300 feet on the vein, and then turns and runs out through the country. The vein shows nothing very interesting at present. It is, of course, understood that it is conglomerate lode of the National Minnesota, Rockland and Superior mines.

Extract from J. B. Townsend's letter, dated Minnesota mine, June 11, 1857:—

Minnesota Mine.—The *most* promising parts at present are around the large masses, between Nos. 5 and 8 shafts, between 10 fathoms and adit Levels, the blocks of ground below to the 30 fathom level, the Branch vein at 10 fathom level, the back of 60 fathom level, and the back of 30 fathom level between Nos. 2 and 6 shafts. At *all these places* there is *heavy mass* copper

with *strong vein exposed.* The other parts of the work show well—though the places mentioned are at this time the most available.

The *Rockland* has a fine run of masses in the vein between Nos. 3 and 4 shafts, and we now expect to *increase* the return for June. They are meeting with a good vein diving west at the adit level, and also east at same level.

The *Superior* are sinking No. 1 shaft below the adit level, where the vein shows considerable more copper than at any other point of the mine, producing good barrel and stamp work. We want depth to bring the Superior out. We have opened on *two veins* north of the works which show well for copper. They are some 100 to 200 feet north of No. 1 shaft, and well marked by the "ancient diggings."

At *Flint Steel* the water has been so troublesome in No. 2 shaft that we suspended that work for the time, but the adit will eventually drain it. The vein is the south or conglomerate lode. From the promising appearance at "Superior," we hope for a change as we gain depth on Flint Steel. The Bluff is higher, and we can hardly expect much change until the work is deeper.

MERRYWEATHER MINE.

"We learn from good authority, that the Merryweather Mining Company have purchased the Mineral locations of Thos. McDonald and Jonathan Conklin, containing together 200 acres, situated west of the Norwich and Ohio Trap Rock mining locations. The Norwich vein, well known by its regularity and richness, and in which lately several large masses of copper have been found, passes through McDonald tract. We are informed that Mining operations will be commenced immediately on this vein. The Merryweather Mining Company will, at the same time, continue operations on their locations near Gogebic Lake, to explore more fully the extensive tract of mineral land which they own in that vicinity, upon which a nnmber of veins of very promising character have been found already."

COPPER SHIPMENTS FROM ONTONAGON.

Passed through St. Mary's Falls Ship Canal, May 23d, 1857.

Mining Co.	Masses	Barrels	Gross wt. lbs.
Norwich	36	76	93 764
Nebraska	3	24	17,922
Minnesota	96	53	138,482
Rockland	9		8,978
Adventure	12	44	35,703
National	89	88	92,422
Copper Falls	23	77	104,239
Total			491,510

Passed June 1st.

Propeller Mineral Rock	370 gross tons.
do Iron City	150 do do

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

QUICKSILVER.

From the importance of this metal in connection with the gold deposits of California and Australia, and a few countries in which it is discovered, we have pleasure in calling the attention of our readers to the following interesting communication from Hyde Clarke, Esq., C. E., London:—

In the course of some researches, as to the gold deposits of Great Britain and Ireland, I found some notices of the existence of mercury, and I was induced, therefore, to make further inquiries. As it is now no longer open to reasonable doubt that the gold resources of these islands are much larger than has been conceived, and that they must hereafter be worked on a greater scale, I thought it advisable to pay some attention to new sources of mercury, the demand for which is already in excess of the supply, and which must become still greater. I know of no reason, *a priori*, on geological grounds, why quicksilver should not exist in these countries, and if little is known with regard to it, it is because no systematic search for quicksilver has been made. So far as I have the means of judging, quicksilver, like other elementary substances, is pretty widely diffused; while I observe that many gold regions contain quicksilver, and, therefore, it is fair to expect that quicksilver may likewise be found in this country, which has an extent of auriferous formations.

Gold and quicksilver are found among other places in Spain, Istria, Hungary, Bohemia, Saxony, China, Mexico, Peru, California and Australia, and quicksilver will, I believe, be found very extensively.

Quicksilver is met with either native or in ores. The chief ores are cinnabar or sulphuret of mercury. Cinnabar is the ore most abundantly found and worked, and is that most valuable.

The chief localities for quicksilver are the following:—Almaden, in Spain, the great source of supply. The mines are in clay-slate and grit, in horizontal beds, which are intersected by granite and black porphyry eruptions. At Almadenejos, the ore and native quicksilver are found in a black schist.

Other European localities are Muschel Landsberg and Almeden, in Bavaria, native in a schistose or quartzose matrix; at Wolfstein, Stahlberg and Moeschfeld, in the palatine of Bavaria; at Kremnitz, Neusol and Rosenau, in Hungary; at Harowits (or Horshoviz,) Swata, and Schoenfeld, Bohemia; at Zorge, in Saxony; in Transylvania, in several places; and at New Maerktel, in Carinthia. In France pyritous ore of cinnabar is found at Menidot, near St. Lo, in Normandy, and in Dauphine. In Italy it is reported near Lake Travale, and at Ripa in Tuscany. It is also reported in Sweden. In Asia, quicksilver is found in Shensi, China, and in Japan. In America, the chief mine is at New Almaden, in California. It is also largely worked at Huanca Velica, in Peru. In Chili, it is found at Arqueros; in Mexico, at El Dector, 150 miles west of the city of Mexico; and in Brazil, near Villa Rica, between Morro das Lages and Santa Ana.

The ores of quicksilver are very numerous in form, and the metal allies itself extensively with other minerals. Among these may be enumerated quicksilver united with gold; quicksilver united with silver; quicksilver with sulphur or pure cinnabar (one variety loose and friable, like red ochre—one variety hard and deep red;) red brown impure cinnabar; liver ore, ditto; burning ore or branderz, ditto; quicksilver with iron or pyritous cinnabar; pyritous mercurial silver ore; arsenious mercurial ore, or realgar, from Japan; quicksilver with copper and sulphur; muriate or hydro-chlorite of quicksilver.

The first notice of the existence of quicksilver in these islands is in the 16th century, in a great work of Aldrovandus, a famous naturalist; it is in the chapter on quicksilver in the *Treatise on Metals*. He says that quicksilver has been found in Scotland, in Britain. It was probably in consequence of the supposition or knowledge that quicksilver existed in the island, that in the reign of Queen Elizabeth a grant was made to Daniel Houghsetter, or Hochstetter, a high Dutchman, and to Thomas Thurand, Master of the Savoy, of the quicksilver and some other metals within the counties of York, Lancaster, Cumberland.—Westmoreland, Cornwall, Devon, Gloucester and Worcester, and within the principality of Wales. A little later a grant was made to William Humfrey, assay master of the Mint, and to Christopher Schutz, a high Dutchman, for this and other metals, within the remaining English counties, and the pale of Ireland. These grants are now merged in the existing corporations of

the Mines Royal of England. Little seems to have been done in consequence of them, as the adventurers directed their attention chiefly to the silver mines, unless we are to be guided by the statements of Moses Stringer, afterwards manager of the corporation, who certainly affirms the existence of quicksilver in England and Ireland, in his *Opera Mineralia Explicata*, p. 9.

Sir John Pettus gives a more direct testimony, for he says—"Quicksilver is found in many veins where the lead lies." (*Pettus Fodinæ Regales*, p. 24.) This very probably refers to quicksilver found in silver or silver lead ores. In the Trapescantian Museum, founded in the 17th century, and now the Ashmolean, there was, as I find from the catalogue, "*Lapis minii vel cinnabaris fossilis*," from Richmond, in Yorkshire. This is, however, most likely native minium, which does exist in Yorkshire. I know of no locality for native quicksilver, or cinnabar, in England.

Reverting to the statement of Aldrovandus, as to Scotland, I have not been able to find the contemporary account from which it must have been derived; but in the end of Queen Elizabeth's reign Sir Bevis Bulmer found native or natural quicksilver in the sea sand, I presume of the south of Scotland. This account is contained in what is known as "Atkinson's MSS.," preserved in the Advocates' Library, at Edinburgh.

Sir Alexander Murray, in the beginning of the last century, announced the discovery of the native quicksilver in the Island of Islay, in the Hebrides, (Sir Alex. Murray's Letter to Sir Robert Walpole.) This discovery is confirmed by Professor Jameson, of Edinburgh, as he visited Islay during his geographical tour among the western islands of Scotland (Jameson's *Mineralogy of the Scottish Isles*, vol. 2, p. 158.) He saw the metal, but the people could not tell him the precise locality—that is to say, the exact spot where the deposit was; perhaps, too, it was small and local.

Another discovery of quicksilver was made in the same century, about the year 1770. The quicksilver was found native in a part of the town of Berwick-on-Tweed, called Hyde Hill, (*William's Mineral Kingdom*, vol. 2. p. 378).

I am not aware of any cinnabar having been found; deposits of native quicksilver are generally small, but cinnabar is sometimes found in the same neighborhood. Thus, it is so found in the quicksilver mines of Idria, in Friuli. It is there found in clay, or in black *lapis ollaris;* and likewise native quicksilver is found with cinnabar at Morro das Lages and Santa Anna, near Villa Rica, in Brazil. It is likewise so found in small quantities near the Lake of Travale, in Sienna, in Tuscany.—*U. S. Mining Journal.*

MISCELLANIES.

SCIENTIFIC FACTS IN RELATION TO MINNESOTA.

(From the Boston Journal.)

A great deal has been written about Minnesota, the advantages of its health-giving climate, the beauty of its crystal lakes, the invigorating elasticity of its atmosphere, its freedom from that horrible disease so common to the Western country, the fever and ague, but I have never yet met with anything very definite about its *soil.* Now as this is unquestionably a very important matter, I have recently submitted to Dr. A. A. Hayes, Assayer to the State of Massachusetts, a sample of the soil which is found in Central Minnesota, or that part lying between the St. Peter's River on the south, and Crow Wing on the north, and extending from the Mississippi on the east to Big Stone Lake on the west. This region embraces the most delightful portion of the

Territory, and is full of the prettiest lakes in the world, abounding in fish, and frequented by innumerable wild fowl. As a general thing here is plenty of woodland, and the soil is of the richest description, as the following analysis will, I think, amply demonstrate:

Results of analysis; Sample of soil, from Central Minnesota, brought by Mr, Whitefield. This was a dark-colored fine textured soil, abounding in organic matter, and highly fertile. One hundred parts in an air-dried state afforded

Moisture	10.40
Humates, Crenates, &c	6.00
Carbonate of Lime	4.60
Sulphate of Lime	1.36
Finely divided Clay and Sand	76.74
	99.10

The organic part of this soil, six per cent. is composed of humates, crenates, and gelatinous compounds of lime with traces of magnesia and phosphates. It is in fact a large amount of natural manure mixed with soil, and cannot fail to produce great and permanent fertility. It closely resembles the sugar-cane soil of the West India islands.

A. A. HAYES, M.D.,
Assayer to the State of Massachusetts.

16 Boylston street, Boston, 15th *April*, 1857.

The following is from Prof. Rogers in reference to the above:

Mr. Whitefield.—Dear Sir: The Analysis here recorded by Dr. Hayes exhibits a soil of composition, and I unite my own humble testimony to all that he pronounces respecting its great natural capacity,

Respectfully yours, &c.,
HENRY D. ROGERS,
State Geologist of Pennsylvania.

Boston, *April* 16, 1857.

The following is in reference to some samples of lake water from Minnesota:

Results of analysis of the waters of Lakes Lillian and Mintaga, from W. Whitefield. The small samples of these waters afforded:

Lake Lillian—Very little common salt.
Considerable sulphate of lime.
Do. crenate of lime.
Do. silicate of lime.
Organic matter gelatinous.
Traces of iron oxide.

Lake Mintaga—Very similar to the above, with the exception that both sulphate and crenate of lime were more abundant.

They are both clear and sweet waters, their characters being those of limestone districts.

A. A. HAYES, M. D.
Assayer to State of Massachusetts.

16 Boylston St., Boston, *April* 14, 1857.

Here, then, we have a pure water and a rich soil, a beautiful country and a healthy climate; and what more can any reasonable man desire?

I wish it distinctly to be understood that the sample of soil here referred to is a *fair* sample, and that precisely such soil is to be found within the limits I have designated, with the exception of that portion of it bordering on the Mississippi river, and extending back from five to ten miles; as it is a remarkable fact that the poorest soil is found near the Mississippi river, and that it improves gradually as you go back. I speak thus positively, because I have traversed that portion of the territory during the past summer and fall, and carefully noted the characteristics of the water and soil, and declare that the sample submitted to Dr. Hayes was a medium quality, and not nearly so rich as some I might have given him.

E. WHITEFIELD.

Boston, *April* 17, 1857.

MINING MAGAZINE.

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WILLIAM J. TENNEY.

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VOL. IX.—AUGUST, 1857.—No. II.

ART. I.—MINERAL RESOURCES OF SOUTH CAROLINA. From the First Annual Geological Report. By OSCAR M. LIEBER, State Geologist.

(Continued from page 30, Vol. IX.)

BEFORE proceeding to the special description of the deposits in the districts surveyed, it will be necessary to explain an important matter connected with them. This seems to me more especially necessary because I never yet noticed any remarks on the subject in works even, which one might reasonably expect to touch upon this topic.

Every gold-miner must have observed that the metal in tpe deposits is of far coarser grain than in the veins, whence they were derived. There is probably not a single exception to this rule, and it is perhaps an ignorance of this fact, which has induced many to believe that they had not discovered the original source of the gold, because the particles in the vein itself were so diminutive when compared with those in the deposits. Had mere mechanical forces been in operation only, the attrition, consequent upon the washing and rolling, must have lessened the size of the particles in the deposit. We must, therefore, look for other agencies to account for the phenomenon, for it is very apparent that an increase, instead of a diminution in size, has taken place.

Before offering an explanation, it is necessary to look farther than to deposits only, and to collect all the facts relating to the subject.

It has been observed in North Carolina and California not only that the upper portions of veins are most productive and contain the gold in the largest granules, but that roots of trees, growing on the tops of vein-outcrops (especially those, it is affirmed, which have been struck by lightning) are sometimes partially almost coated by the precious metal. We see also that every laborer at gold mines is induced to put the question, "Does gold grow?" when he finds old tailings, that have been allowed to accumulate for years at the gold mills, still, when re-washed

at successive intervals, returning almost as much gold, and sometimes more, than when operated upon the first time.*

Gold really does grow and is continually growing, though certainly not in the way in which the querists understand it. That is to say, an individual particle may grow, may increase in size, but the smaller ones are absorbed into the larger, and no actual increase in the quantity present has been effected. An increase has really taken place in available, attainable gold, without any increase in the actual sum total. As all separations of the metal from its accompaniments on a large scale are imperfect —if we except the method practised at Oker in the Hartz Mountains—the finer particles escape. These are therefore contained in the tailings. Atmospheric action, chemical decomposition and the electric currents, which they produce, are the probable causes of that agglomeration, which renders the gold, after a protracted period, sufficiently coarse to become again available to the amalgamator. To such an explanation, at least, we are led by observing the fact of the accumulation of the metal around roots; although this might point also to the possibility of the existence of a natural sulphuret of gold, disseminated in infinitesimal particles in the iron (or copper†) pyrites. The sulphur of this (and consequently its presence likewise) analyses could not possibly detect, owing to the far greater quantity of sulphur in the pyrites. If this be the case, the gold might have been separated in consequence of its coming in contact with carbonaceous matter, in the same manner as an oak-leaf was coated with copper in the Langheck near Weilburg in Nassau (in Professor Sandberger's collection at Weilburg). Breithaupt, in his Paragenesis mentions somewhat similar cases of the formation of iron pyrites, pp. 21, 22. Perhaps, also, the increase of the particles of gold in size, may have been effected by the simple force of aggregation, producing a translocation of the particles (Paragenesis, p. 23). These hypotheses as to the cause may perhaps long remain uncertain. They may, however, serve to induce farther observations. For the

* In an article by Freiesleben on the occurrence of native silver in Saxony ("Jahrbuch, von Leonhard und Bronn, 1845," and "Berg und Huettenmaennische Zeitung," 22d October, 1845,) he alludes to the supposed formation of native silver in old attle piles, and in the ancient hitch, made for the support of timbers, at the Drei Weiber mine. Both of these cases would seem to gain support by what has been said regarding gold, for the writer's unwillingness to subscribe altogether to this opinion would scarcely have existed, if he had been acquainted with the formation, or more correctly speaking, aggregation of gold in the piles of old tailings.

† I have in my possession a beautiful little specimen of malachite from the McGin mine in North Carolina, in which a few particles of gold of some size are distinctly discernible, thoroughly imbedded in the copper ore. As this gold is far removed from any ferriferous mineral, the specimen proves, with much greater distinctness than the most careful analysis even, that copper pyrites (the source of the malachite) was the original matrix of the gold.

present it must suffice, that the facts, for the explanation of which they were offered, are certainly such as they are represented to be, and that the discharge of the sulphur from the pyrites and a consequent exposure of the gold to the action of the mercury, is not the only change effected in such cases.

In the following description of the deposits, those only have been enumerated which are of sufficient importance to be mentioned separately, or those few, where the veins, whence they were derived, have not yet been opened or have no sufficient points of interest to have been treated in describing the veins. The others have already been mentioned under the head of the vein mines in connection with their mother veins, for it would have been injudicious to divide the description of one and the same mine, to suit the character of its respective parts.

The Martin mine is situated on the waters of Wolf creek, in north-western York, and is the most extensive deposit I have yet seen in the State. The area of the gravel bed is about four acres, its greatest depth twelve feet. Its shape is oval, the broad part being on the north-west. The longest diameter is from the N. W. to S. E. The underlying slate forms a ridge in the centre, so that the deposit has filled two distinct depressions; its depth over the top of the dividing ridge being but one or two feet. Towards the sides the deposit thins out entirely, but the surface is almost every where auriferous.

The material forming the deposit, is gravel and white pipe-clay, in alternating layers. The gravel consists of rolled quartz, of which some pebbles are half a foot in diameter. Ordinarily the size is about three inches, and decreases from that down to half an inch. The quartz is white and saccharine, and, therefore, if it had ever been intended to work the mine properly, these pebbles should have been crushed (see sugar quartz veins). The operations have, however, been confined to washing the gravel. Some few pebbles, of more crystalline quartz, are seen, but these contain no gold. The pipe-clay, even when perfectly free from all perceptible quartz particles, is highly auriferous, and my pannings gave most favorable results, although the unctuous character renders it troublesome to pan and necessarily causes a loss of gold.

The almost total absence of all coloring matter (hydrated peroxide of iron) is a noticeable peculiarity of this mine.

This deposit was derived from veins which crop out close at hand. Other veins show themselves on the hills around. As the original source lies so close at hand, a powerful gyratory motion must have been exerted to round the pebbles to the extent to which they are now seen.

This mine was first worked about 1836 or '38, by Daniel Smith and Dawkins, who obtained a lease for ninety-nine years from Martin. This lease has repeatedly changed hands, and the

mine is still worked upon it. At the time of my visit, two and a half hands only were occupied there. The gold is coarse and easily obtained. Large particles, of the size of a pin's head, are common, and nuggets weighing seventeen ounces and nine and a half ounces have been found. One piece of quartz, about one quarter cubic foot in bulk, contained 210 pennyweights, another over 4,000. In May and June, 1852, Messrs. Beam, Gill, and Allison, with the labor of two men and two boys and the use of rockers only, made $5,700 worth of gold. But for a short period was a drag mill ever at work here; otherwise rockers have alone been employed.

The gold is worth ninety-eight cents per pennyweight.

The *Brothers Belk's deposit* is situated in Lancaster district, a mile or two north of the road from the Court House to Taxahaw. It was a complete surface deposit, about two feet thick at the deepest part, and covered a quarter of an acre only; yet it yielded with four hands during two months, the sum of $6,000. At present it is entirely exhausted. The purity of the gold was seventy-three per cent., much silver being present. The value of the latter metal, obtained from the whole, was $200. Farther searches were unsuccessful, except in the discovery of the lenticular veins already mentioned.

Some deposits of gold, which are, however, unimportant, are found near Chesterfield Court House. The most prominent of these is on Mr. Craig's and Mr. River's land. But even they are shallow and inextensive. As long as they last they may, however, be profitable. At Mr. River's place some veins also occur, which will certainly yield copper in depth (see copper).

Westfield creek deposits are likewise in Chesterfield, and are situated north of Cheraw, near the North Carolina line. The deposits contain a great abundance of tertiary pebbles. Whether the origin of the deposits themselves is referable to that geological period, or whether the pebbles occupy a position different from the one assumed during the period of their formation—in which case the deposits would be more recent—it is scarcely possible now to determine. The deposits contain no substances that could positively indicate a later origin, and, as the character of the deposits strictly corresponds in all respects with the other decidedly tertiary gravels of the district, there is certainly no sufficient reason to imagine a more recent source.

The gravel bed contains much clay. The gold is coarse, as might be expected. The work performed here is very insignificant, and is confined to occasional washings by the poor inhabiting the neighborhood. Long ago Mr. Blue, at that time the proprietor, made some practical explorations, which, however, were not long continued.

To enumerate all the deposits along branches and elsewhere in a district like York, for instance, would alone fill a volume;

for, in the north-western part of that district, there is scarcely a water-course whose sands do not contain more or less gold (see geognostic sketch of that region in this report). The deposits here mentioned are all of those whose importance is sufficient to demand our attention in these cursory observations.

Copper.—This metal is entirely new among the discovered minerals of our State; and, as there are numerous unexplored mines of this metal, some of which are of the highest promise, the subject merits our especial attention.

The area of the occurrence of this metal extends, it would seem, over the whole of the up country, in other words over the entire portion of the State, which contains those rocks, in which alone we could expect to find veins of this metal, and indeed of any metals at all. Thus, in the course of this year's survey, I have found copper in York, Lancaster, and Chesterfield, while about a year ago Mr. Friedman (then in the service of a Charleston company operating in Pickens) discovered the metal in that district. Cupriferous specimens have also been sent me from Abbeville, and my attention was kindly called last winter to the presence of a small quantity of copper pyrites in a little quartzose vein of the granite at the quarry of Messrs. Green near Columbia. This was too small, however, to be of more than scientific interest. Still it forms a valuable link in determining the area of distribution of this metal in South Carolina. In Union, Spartanburg, and Greenville, copper has also been found.

It would certainly be an absurdity—an unwarranted stretch of the imagination—to term every occurrence of copper a copper mine; for the metal is found occasionally in rocks, where there is no possibility of discovering it in any available quantity. Thus crystalline slates often contain particles of the metal, without affording any reason to expect a greater amount (Alabama). In York I also found copper in the limestone. Nevertheless, these occurrences are indications, in a general way, of a cupriferous region.

Unfortunately the existence of copper in the State has not yet received a sufficient appreciation from men of capital to further the necessary explorations in the proper manner. The novelty of the investment and an obvious aversion, readily to be understood, it is true, to place the necessary confidence in those whose studies and whose profession supply them with the best means of arriving at correct conclusions, has hitherto placed a barrier in the way of opening our copper mines. Where attempts have been made to explore their contents, the insufficient means of the proprietors, or the fact that advice from competent persons was disregarded, or that this advice was sought from those whom want of experience rendered incapable of supplying it, have been the causes of whole or partial failure. Still it must be evident to all, that, if the results of this survey are to be of value to the

State, energetic individual enterprise must avail itself of the discoveries made, and it is to be hoped that the State itself can supply this without having recourse to that derived from a foreign source. The increased value of copper should serve as an additional inducement, especially as the United States are obliged to import (chiefly in pigs from Chili) one-third of the copper consumed. Ores always find a ready market at American furnaces, as well as European ones, at Swansea for example. Thirteen thousand tons of the metal were produced last year at all the American furnaces. This is, however, only about a fifteenth part of that smelted at Swansea in England.

A large class of our gold veins become copper veins in depth, the ores of lead occurring sometimes, though not always, between the two. While engaged in the geological survey of Alabama, I had occasion to observe facts in regard to this, which, when viewed in connection with analogous cases here and in North Carolina, led to the suggestion of a theory, which I explained in an article in the New York "Mining Magazine," of October, 1855. Professor Cotta of Freiberg, at a meeting of the association of miners and geognosists, read an abstract of the paper which appeared also in the "Berg und Huettenmaennische Zeitung" of the 2d of April, 1856; adding some remarks of his own. It was interesting, after writing the article, to find in Cotta's "Lehre von den Erzlagerstaetten,"* p. 44, an imaginary case mentioned (no actual instance of which he was enabled to adduce) which served as an explanation of cases of the kind.

Figure 4, on Plate I., is the same which was first represented in the "Mining Magazine," and the advantages of continued observation have led me to regard it as correct in the main, although it would appear from the Johnston mine (q. v.) that the ores of lead may be replaced by other metals.† This drawing does not represent a section of veins, actual or ideal, but is intended to render more plainly visible the varying features of different veins of the same class, influenced by different surface levels and

* This work appeared in 1854 and 1855. The remarks in it and in the article already mentioned, were based upon independent observations, a fact which increases the probability of their correctness.

† Professor Cotta, in remarking upon the paper already mentioned, observes, that the presence of lead in such veins occasionally, though not regularly, should refer them to different groups. I having suggested that their irregular accompaniment of lead might be ascribed to a casual introduction of salts of lead into the solution, from which the gangue and ores were precipitated. It is perhaps not yet laid down with sufficient definiteness, what difference of character constitutes a separate class of veins. At all events, the opinions of that eminent geologist are regarded by me with too much respect to permit me to pass them by unnoticed, even though this is an official report and not a scientific dissertation. Nor would it be dealing candidly if, in support of his conclusions, I did not again call attention to the Johnston mine, where, if copper be actually found in depth, as it is anticipated, we would have an instance of the replacement of the ores of lead by those of manganese.

by a locally distinct, though analogous distribution of the contents. It is, therefore, what might be termed a *schematic* drawing ("schematische Zeichnung," Cotta terms it), if the coinage of a new word is no inexcusable offence.

In this drawing "D E" represents what may be considered to have been the original surface of the vein out-crops (not of the country, for the sketch does not deal with the country rocks at all), while "D F" is the line which marks the level of the outcrops as they now appear; the upper parts having been removed by the destructive agencies of water and of atmospheric action. "A A" is the portion occupied by auriferous iron pyrites, and, when the pyrites is decomposed, by auriferous hydrated peroxide of iron. It is the gossan of the vein, and wherever the line "D F" rises above the lowest level of "A A" the veins (which are marked "*a*, *b*, *c*, *d*, *e*,") possess an auriferous gossan. The wedge-shaped portion "B" is the region of lead, its form being intended to indicate its irregular and variable presence; for in most cases I now find that this metal is omitted. "C C" is the part of the veins occupied by the copper, which generally touches the area occupied by the gold-bearing gossan, owing to the frequent absence of the plumbiferous region.

In this theoretical section, we find a complete illustration of all the cases that may present themselves to the observer, in the class of veins we are now discussing. Thus "*a*" and "*b*" represent in its different parts the veins of the well-known Morgan or Leighter mine, near Limestone Springs, in Spartanburg; while "*c* and "*d*" exhibit the character of the veins of the Brewer and Edgeworth gold and copper mine in Chesterfield. "*d*" is likewise explanatory of the Hagin and the Wilson mines—the former in Lancaster, the latter in York; while finally at "*e*" we find a vein with no auriferous iron pyrites remaining, and where, therefore, lead being absent, the copper zone is struck at the surface, as is the case at the Mary mine, in York. As the same vein is seen at the Wilson and the Mary mines, this drawing—if regarded as a longitudinal, actual section of one and the same vein—is capable of explaining the reason why, owing to different levels of the surface, the selfsame vein may be at one point, that is to say, close to the surface, a gold-producing vein (as at the Wilson), and at the other, altogether a copper vein (as is the case at the Mary). It shows also, collaterally, how at the latter a great advantage is gained for mining operations; for in this instance it is not necessary to penetrate through comparatively unprofitable (i. e. auriferous) portions of the vein, before the less valuable but more productive metal, copper, is reached.

This is the same class of veins which, in regard to its auriferous contents, was first noticed among the gold veins, where many of the mines belonging to it were discussed. For the sake of convenience in reference, the name of the "Carolina group" was

proposed for it, as was that of the "Ducktown group," for another class of copper veins to be mentioned hereafter.

The mines of the Carolina group, which demand our more immediate attention, are the Mary mine, the Wilson mine, the Smiths mine, and the Sutton mine, in York; the Hagin mine in Lancaster; and the Brewer and Edgeworth mine in Chesterfield. All but the first have been described under the head of gold, although some of them, if not all, will doubtlessly prove, at a future day, more productive as copper mines, than they have been as gold mines. The Mary mine is therefore the only one to be spoken of here.

The *Mary mine* is situated in York district, four miles and a quarter north-east of the Court House. The vein, as already observed, a southern prolongation of the vein of the Wilson mine, is a contact vein between a porphyry dike and the mica-slate, the porphyry itself being a contact dike of the granite. The latter is here of a gneissoid character, although this peculiarity is quite local. At one point the porphyry spreads out on both sides of the vein.

The strike of the copper vein is N. 25° W. its dip about 85° towards the N. E. The quartz of this vein is of a remarkably fine crystalline character. The copper pyrites, protected from decomposition by the constant water of a little stream, which runs over the outcrop of the vein, is found immediately under the surface. A small exploring pit, seven feet in depth, which was sunk at my direction, produced native copper. The proportional increase in width, per foot in depth, is at that place, five-sevenths of its width; for, commencing with half a foot at the surface, it widened to two and a half feet in a descent of seven feet. Ordinarily, the width at the surface is three feet.

This mine has as yet been unattended to, but I trust it is not too bold to promise that it will not long remain so; for indeed it would be difficult to discover finer prospects for a copper mine, or a location more favored with the conveniences of a railroad for the transportation of the ore or pig metal. I do not hesitate to express my conviction, that not only is that day close at hand, when explorations, carried to a proper depth, will fully develop the character of this mine, but that the period is scarcely more distant when it will add a most important item to the exportations of our State, and prove the initiative cause of a more extended commerce, while, at the same time, the good example given by a well-conducted and profitable mine, will give a new impetus to honest mining enterprises.

Besides the vein already mentioned, there are others at this mine, two of which are eighteen feet in diameter; the one striking N. 80° E., and therefore meeting the main copper vein, the other N. 37½° E., and consequently crossing the first as well as the copper vein. These veins, in all their characteristics, strictly

resemble the veins at Mr. Morgan Dover's, on Wolf creek, in York district. For the present, it must remain unsettled whether these veins should be regarded as belonging, strictly speaking, to the Carolina group, although they are also auro-cupriferous. At all events, it is proper to consider them as a distinct subdivision of that group, for the same reasons which, when treating of their character as gold-bearing veins, induced a separate classification (see gold veins). Nevertheless, as these instances are quite isolated, it is necessary to avoid too great precipitation and to await the results of more protracted observation.

Instances of these veins, we find at the Mary mine and at the Morgan Dover mine. All consist of a saccharoid quartz. They are likewise auriferous, and, though they contain copper, the ores of this metal appear scatteringly, disseminated in minute particles, and not in the massive manner in which they are seen at the main copper vein of the Mary. Possibly the copper found in the sugar quartz veins of the latter mine may be erratic, and derived only, by subsequent transposition, from the chief copper vein. To judge from the analogy of these veins with other sugar quartz veins (which, it is true, are auriferous only), proved by experience to cease upon striking the hard country rock, their value becomes doubtful. Still, it would be wrong to pass final judgment upon them without a previous careful observation of their character in depth, for which the limited mining operations of our State do not, as yet, afford an opportunity.

Allusion has already been made to that class of veins which appears at Ducktown, in Tennessee, and extends south-westward into Alabama, and north-eastward into Virginia, through the valley which separates the Blue Ridge from the Alleghanies. Its characteristics are a poryhyroid mixture of iron and copper pyrites, the latter being the matrix, though the cubes of the former exceed it in bulk. The porphyroid structure is singularly distinct in some of the Georgia mines; for in many of the Ducktown ores, this otherwise unusual, relative position of the two minerals, does not exist. The composite mass fills the vein crevices to the almost entire exclusion of other minerals, which usually abound in veins, though sometimes we find quartz on one or both walls. Owing to decomposition of the compound ore, the upper part of the veins consists of impure peroxide of iron, whence the copper, as sulphate, was leached and deposited, with a partial formation of the black oxide, in the lower part of the decomposed area, and therefore immediately above the unaffected sulphurets. Here then we find a richer ore, owing to this natural concentration, than immediately below it. It appears, however, from recent explorations, carried on by English companies, at Ducktown, to a depth of 350 and 400 feet, that a gradual increase in the value of the ore takes place in descending, and, indeed—if we may apply the evident rule of the veins of the Carolina group to this

class also—a diminution of the quantity of iron pyrites and an increase of that of copper pyrites in depth was reasonably to be expected.

Whether this Ducktown group is absolutely confined to the valley between the two chains of mountains, already mentioned, the future must decide. Hitherto no veins, petrographically synonymous, have been found beyond its bounds. There is, however, on Nanny's Mountain, in York, the gossan outcrop of a bed-like vein, which, from the great similarity of its constituent iron ore with that of the established cupriferous veins of this class elsewhere, has led me to suggest the great probability of the future discovery of copper at that place; although the experienced vein geognosist will discover an objectionable feature in the fact, that the vein outcrop forms the backbone of a mountain, of some prominence when compared to the ordinary surface levels of the adjacent lands.*

Like the gossans of Ducktown, the upper part of this vein was worked for iron ores in former times, the furnace, which was supplied by it, being indeed the first erected in South Carolina. It was established by Col. Hill and Wm. E. Hayne prior to the Revolution, and, being employed in casting balls at the time of the war, was burnt by the British on their route to Charlotte. Bloomeries were afterwards built here, but it is now already more than forty years since the company failed, owing as well to an inferiority of the iron as bloom iron, occasioned by the same hardness which rendered it particularly suitable for certain castings, as the greatly decreased quantity of timber for fuel in the neighborhood, and the expense of transportation.

The gossan of the vein most remarkably corresponds in its constituents with the porous hematites, which cap the veins of the Ducktown group. It was this feature which first led to the surmise, that possibly this case might overturn the previously-formed opinion, that the veins, which correspond petrographically with those of Ducktown, are geographically confined to the long valley region already mentioned. In this case, South Carolina would after all not be entirely excluded from veins, which, though remotely separated from the rest as to locality, are synonymous in internal features. In a case, however, which is so entirely new, it is best to await the certain decisions, to which actual underground explorations alone can lead, when definite conclusions, based upon analogies with established ones, are impossible. As the mountain on which this vein occurs is very precipitous on the side towards which the latter dips, a level at a great distance from the out-crop might be driven, which, without the inconvenience offered by much water in a shaft, would soon strike the vein and

* I do not offer an explanation, but merely state this as a generally observed fact.

determine its character in depth, at a comparatively small expense; while the great value attaching to so important a discovery of copper ought to be a sufficient inducement for the undertaking.

The strike of the ridge of Nanny's Mountain, with which that of the vein corresponds, forms an S. Commencing on the south, we have the following succession of strikes:—N. 31° E., N. 10° E., N. 5° E., N. 28° W., N. 37° W. This is the termination of the mountain on that side. The vein, however, continues striking first N. 10° E. and then N. 45° E., after which it is cut off by a dike of syenitic porphyry (quartz and hornblende). The dip of the vein varies in direction, of course, in the same manner as the strike; being first, S. 59° E., S. 80° E., S. 85° E., N. 62° E., N. 53° E., and afterwards, S. 80° E. and S. 45° E. The angle of dip is variable, but ordinarily very great.

Lead.—This metal I have not found extensively in any part of the district hitherto surveyed, although of others, Spartanburg for instance, a very different remark must be made. The actual discovery of lead ores is confined, but there is at least one case, at Mr. Stroud's, in Lancaster, which, although unexplored by mining operations, affords indications that point to their existence in great abundance in depth. Other places, where lead occurs, are at the Pott's mine, in Lancaster (q. v.), and at the Brewer and Edgeworth mine in Chesterfield; while lead is said to have been found in a six-foot vein on the land of Jonathan N. Stuart, near the King's Mountain battle field, a vein which abounds in fibrous black hematite. Lead is also reported to have been discovered by the Dovers on the Silver Mountain near Dolittle creek, in York, though there is reason to believe that this arose from a mistake, occasioned by a slate bed abounding in iron pyrites, which was observed there. That, however, this portion of York should contain lead is far from improbable, as we have the Morgan lead mine in Spartanburg, and as galena has been found in isolated pieces on the property of the Swedish Iron Manufacturing Company in the corner of Union; while I discovered this ore at Brigg's gold mine, in North Carolina, close to the York line.

At John H. Stroud's, Esq., in Lancaster (marked Yarborough on Walker and Johnston's map of the State), we find a collection of veins, which we must not overlook in speaking of occurrences of lead. The character of one of them, which strikes N. 74° W., from its similarity with that of the Morgan and the Pott's mine, having induced me to express a conviction that lead would be discovered, it gave me pleasure to find the opinion verified by noticing some soon after. This is, however, neither the main vein, nor the one, which gives the best promise for lead. The most important one, striking N. 10° W. cuts off the other. This vein may be traced for one and a half to two miles, and, at its

northern termination on Mr. Stogner's land, it forms a large outlying outcrop. Every where this vein presents the same petrographic features, which serve as very decisive marks of distinction. The quartz, which, at the surface, is amorphous, is traversed in every direction by minute veins of crystalline quartz with distinct concentric crystallization. These often present beautiful little slides, and afford cabinet illustrations of a variety of the phenomena observable with veins. Their presence is to a great extent, if, indeed, not altogether, owing to the removal of substances formerly existing in the matrix, whose absence produced cavities and seams. Of these calcspar was one; for the spaces now vacant, which were occupied by this mineral, are often distinctly discernible on account of its crystalline forms. Quartz of this description, especially when, by the cavities left, it proves the original presence of calcspar, so common a companion of lead and silver ores, must be viewed as eminently favoring the supposition that these metals will be found below. There are ample grounds for the conviction that the future will prove such to be the case with the first metal at all events. This vein will, however, certainly show itself entirely different from those of the "Carolina group.". The principal vein here is less accompanied by a ferriferous outcrop than that which strikes N. 74° W. but which is evidently a minor vein, and but little more important than a similarly striking companion vein close to it.

Manganese.—Of this metal no deposits of technical importance have yet been found, although the existence of a manganesian bed in the talcose slate of King's Mountain, already described by Mr. Tuomey, and of the pyrolusite in the quartz vein of the Johnston mine, (q. v.) are noticeable facts.

Bismuth.—This metal was discovered by Mr. Tuomey at the Brewer mine, both native and in the form of a carbonate. Unfortunately, when I visited the mine, the shaft in which it was found had been allowed to cave in, so that no observations of its position and modes of occurrence could be made.

Professor Rammelsberg, of Berlin, in his dictionary of chemical analyses (4th Supplem. p. 262), gives the results of an analysis of the carbonate of bismuth, which he terms bismuth spar, the specimen being from this mine presented to him by me. These were:

Oxide of Bismuth	82.63
Perox. of Iron	2.55
Alumina	1.79
Lime	0.28
Magnesia	1.60
Carbonic acid	6.02
Silicic acid	2.97
Water	3.16

Dr. Genth informs me that he found traces of tellurium, and hence regards it as derived from tetradymite.

Iron.—This metal is met with in workable quantity only in York, though ores of it have been found elsewhere. Thus a deposit of bog-iron ore occurs on the Steel Creek road near Cureton's Store, north of Lancaster, and some fine magnetite appears inextensively in north-eastern Chester, not far from Moffat's store. Magnetite also abounds in the porphyroid and trappean rocks of Chester and York, sufficiently so, indeed, to affect the land surveyor's compass in running out long lines, though disseminated through the mass of rock in such minute particles that it is not of any practical value. At Nanny's mountain amorphous porous hematite was once employed at the furnace there, but circumstances, chiefly unconnected with the value of the ore, have induced its abandonment. On the waters of Wolf Creek, in north-western York, specular schist beds were formerly worked, and the ore smelted at Stroud's furnace, which has long ago ceased to operate. The only occurrences of iron ores at present practically important are, therefore, confined to the corner of York, west of King's Mountain and its southern prolongation.

With regard to the ores, the mines may be separated into those of magnetite, of specular ore and of hematite, a division of importance in the eye of the smelter, although petrographically the distinction need scarcely be made, as the changes are here probably all induced by secondary action, and are, therefore, chemical alterations of the same substances in the same positions.

Perhaps, as will be seen from the following remarks, it would have been more systematic to treat the rocks—for such they are —which are there worked as ores, in the chapter on the general geognostic features of the region. A desire only to include all the useful minerals in the present chapter causes me to introduce their description here.

Most important of the ores, in a geognostic point of view, is the *specular schist** (siderocriste, Eisenglimmerschiefer, fer oligiste micacé) for in it another companion of the itacolumite may be added to the list, which produces so great a similarity between the occurrence of this singular rock in our State and in the Brazils. Such comparisons are not only interesting, when scientifically regarded, but, as they tend more perfectly to establish the character of a country, or a formation, they often lead to deductions, whose practical value is apparent. In the article on the itacolumite in the second chapter, a comparison between its accompanying rocks here and in South America, is instituted, and it will, therefore, at present be necessary only to describe the specular schist.

This rock is exceedingly rare—for the only localities hitherto described or mentioned are in the Brazils, Marmoras and Provence. As true specular schist, the Bird bank or specu-

* A name suggested to me by Professor Dana.

lar ore bank can alone be named. This is seen at various points between the western declivity of King's Mountain and the southern lime outcrop, extending thence south-westward to the two ranges of hills which bound the Dolittle (or Dearlittle) Creek—the Dolittle and Silver Mountains. On the former of these the outcrop is wider than at any other point observed; for they have already quarried across it thirty-five or forty feet, without meeting any interruption. Indeed, the whole of the hill consists of alternating beds of quartz, talcose and specular schists. The greatest thickness of the latter is between the itacolumite and talcose slate. The strike of these beds is N. 41 E., the dip 64½° S. 49° E., but, owing to folds of the rocks, some quartz beds strike N. 5° E., and some of the talcose slate N. 11° E., both being vertical in dip. The interrupted extension of the beds of the specular slate north-west and south-east at this point is about half a mile, though in its north-eastern prolongation it gradually becomes narrower, until east of the place of A. Harding, Esq., it finally gives out.

On the Dolittle Mountains we find this remarkable rock not only most perfectly developed as regards extent, but also most strongly marked in its peculiar petrographic characters. Here it presents so great a similarity with some micaceous schists, that, at first sight, few would suppose it to be any thing else. In color it is steel-gray, but its crimson streak, when scratched, distinguishes it from mica-slate, to which it possesses a resemblance in the laminated or scaly nature of the individual parts of the iron glance. Sometimes, especially farther north, this feature disappears to a considerable extent, and the rock becomes less schistose and granular, owing to the shape of the minute crystals of the iron ore. In these cases talc generally enters more conspicuously into the composition of the rock, and, owing to the presence of a small admixture of magnetite, it becomes slightly magnetic. As an ore this rock is greatly valued at the furnaces, though not used to any extent at the bloomeries.

Where atmospheric action has been able to effect the rock, the specular iron (anhydrous peroxide) is converted into earthy hematite (hydrated peroxide). This generally forms as a crust and the mass contains harder nuclei. We shall have occasion again to return to this ore.

The magnetic iron beds of this region seem to be synonymous with the *itabirite* of Eschwege, although in South Carolina the quartz is present in less quantity, and the accompanying talc greatly increased in amount to that which, according to description, seems to be the case at the Peak of Itabira, the Sierra-da-Piedada and other Brazilian localities. With us the rock essentially consists of talc (or chlorite) and crystals of magnetite, the former being the matrix of the latter, while talcose strata less admixed with magnetic iron, are intercalated between the others.

These do not affect the needle, while the former are highly polaric. Wherever I have examined beds of this rock, as for instance at the Lee and Parker bank and the ore beds of the Swedish Iron Manufacturing Company in the corner of Union (both of which are outcrops of the same bed), dikes of melaphyre or of diorite appeared in the immediate vicinity; so that it is not impossible that the magnetite may have resulted from a partial reduction of the peroxide of iron of the specular schist to a protoxide.

This rock also occurs at the junction of the itacolumite and talcose slate, and, therefore, gives additional reason to regard it as a continuation of the specular beds, although separated from it superficially by the itacolumite. At the Lee and Parker ore bank it is immediately underlaid by a barytic vein, the width of which has not yet been determined. The heavy spar, likewise, appears as streaks or intercalations, and the vein also cuts off the ore bed occasionally, and may, perhaps, have been the means of the introduction of that sulphur which has converted the magnetic bed into a pyritiferous one at a depth rarely exceeding sixty feet. Accessory minerals which are found there are:—mesotype, hyalitic quartz, chlorite, very pure talc, asbestus, staurolith, and, owing to the decomposition of the pyrites, sulphate of iron.

The strike of the bed at the Lee and Parker bank is N. 47° E., its dip 60° S. 43° E. The bed continues, with one or two apparent interruptions, and crosses to the east of the summit of King's Mountain in North Carolina. That this interruption is a seeming one only and altogether confined to the surface, is decisively evinced by a most singular fact. When Briggs sank a deep pump shaft at his gold mine in North Carolina some years ago, the works at the Parker, as well as the Lee bank, at least thirteen or fourteen miles distant, were entirely drained, filling again when he stopped his pumps and draining a second time, when Commodore Stockton put them in operation again. The connection would appear imaginary, notwithstanding this remarkable fact, as the gold vein of the Briggs' mine lies to the west of the iron bed, and as this bed at the ore bank dips S.E., but such cannot continue to be the case, when we recollect that in North Carolina the beds on the west of the mountain range dip N. W. They thus form, in their south-western prolongation into our State, a saddle-shaped alteration in dip, which admits of an easy explanation in the folds of the rocks (as shown on plate V.), of which this region is constituted.

As an ore, this itabiritic rock has long been appreciated, and will continue so until the destruction of the forest growth—no remedy for which has hitherto been attempted—will render the charcoal used too expensive to prosecute the manufacture of iron with advantage. This fatal result can be avoided only by a thoroughly-organized cultivation of woods.

The ores of this region yield a steel which is probably un-

rivalled even by that derived from Swedish iron, and their fame has already extended to England, where a company is now contracting for the purchase of the property of the works.

We now arrive at the *hematite* beds, which sometimes, owing to admixtures of breccia of magnetic iron and iron glance, exhibit a similarity with Eschwege's South American *topanhoacanga.* Where this is the case, the composition not only, but also the position, is ascribable to secondary action. Of technical importance are those beds alone which still retain their original position, and whose present composition is the result of the assumption of water by specular beds, or the additional partial oxidation of magnetic ones.

Beds of this amorphous hematite are seen on Whitaker's Mountain, on the western slope of King's Mountain (a continuation of the specular schist probably), on the south of the southern lime and occasionally between the two limestone outcrops. The former have alone been worked to any extent. The first is termed the Harding bank, the second, the Bird bank.

The strike of the beds is N. 30° E., the dip of the third part in figure 4, is 70° N. E., and of the two others west of it, 45° to 70° in the same direction. The eastern part of the bed is indicated in nature only by disconnected bodies of ore, of little practical value.

These beds are, like the others already described, placed at a short distance only from the itacolumite; and but little doubt can therefore exist, that the outcrops of all these (though distinguished by different ores of iron) really belong to the same original bed, and that a deviation from its original horizontal position has been the main cause in occasioning them to be considered as separate and distinct.

BROWN COAL OF THE CHERAWS.

The brown coal, or lignite, is found in beds belonging to the tertiary formation of Chesterfield. The principal locality observed is on Whortleberry branch, immediately north of Cheraw; although I also found some near Mt. Croghan. In sinking wells, others have discovered it in Marlboro's where indeed there is reason to believe the main body of the bed will be found.

The highly-bituminous nature of the clay, and the compactness and want of a distinctly-ligneous character of some of the brown coal beds, obliges us to regard this discovery not as an occurrence of isolated pieces of bituminized tertiary drift wood, but as portions of regular brown coal deposits. Upon the value of these it would in few countries be necessary to enlarge. The United States are, however, so extraordinarily favored with finer qualities of coal, that brown coals have been treated with greater contempt than they merit.

While writing this very report, I received a letter from an

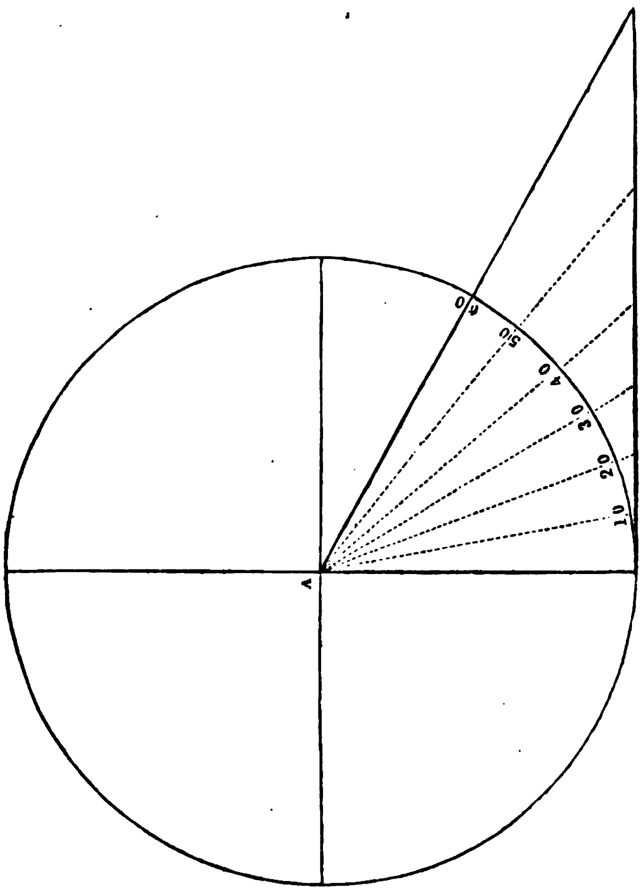
esteemed friend and fellow student, M. Furuhjelm, the chief mining engineer of the Russian American Company. Writing from Cook's Inlet, he informs me, that for about a year he has been engaged in opening a brown coal deposit, to be possessed of which the company congratulates itself, as, by its means, they expect to establish an important coaling ground for the Pacific, and to supply the California market with a most necessary commodity.

(To be continued.)

ART. II.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 6.

(Continued from page 34, vol. ix.)

SECOND TABLE. PERPENDICULAR RADIUS, ONE FATHOM.



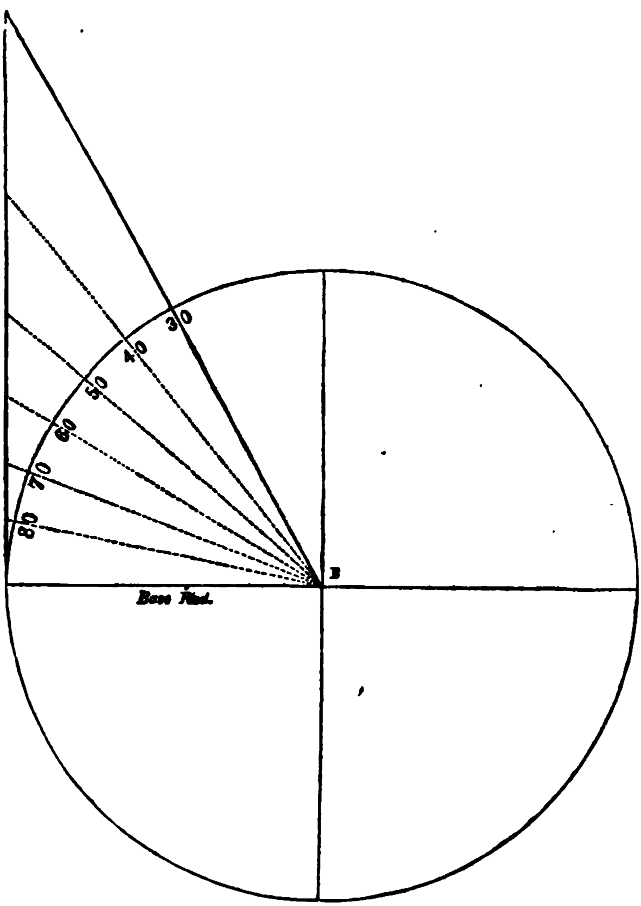
ANGLE.		BASE.				HYPOTHENUSE.			
Deg.	Min.	Fath.	Feet.	Ins.	Decimals.	Fath.	Feet.	Ins.	Decimals.
1		0	0	1	·2568	1	0	0	·0108
	15	0	0	1	·5710	1	0	0	·0171
	30	0	0	1	·8854	1	0	0	·0247
	45	0	0	2	·1998	1	0	0	·0335
2		0	0	2	·5143	1	0	0	·0432
	15	0	0	2	·8289	1	0	0	·0554
	30	0	0	3	·1435	1	0	0	·0684
	45	0	0	3	·4582	1	0	0	·0828
3		0	0	3	·7728	1	0	0	·0986
	15	0	0	4	·0882	1	0	0	·1159
	30	0	0	4	·4035	1	0	0	·1346
	45	0	0	4	·7189	1	0	0	·1544
4		0	0	5	·0328	1	0	0	·1757
	15	0	0	5	·3496	1	0	0	·1960
	30	0	0	5	·6664	1	0	0	·2171
	45	0	0	5	·9825	1	0	0	·2484
5		0	0	6	·2993	1	0	0	·2736
	15	0	0	6	·6168	1	0	0	·3024
	30	0	0	6	·9336	1	0	0	·3312
	45	0	0	7	·2497	1	0	0	·3636
6		0	0	7	·5673	1	0	0	·3960
	15	0	0	7	·8841	1	0	0	·4298
	30	0	0	8	·2008	1	0	0	·4658
	45	0	0	8	·5212	1	0	0	·5028
7		0	0	8	·8402	1	0	0	·5400
	15	0	0	9	·1584	1	0	0	·5803
	30	0	0	9	·4788	1	0	0	·6192
	45	0	0	9	·7992	1	0	0	·6624
8		0	0	10	·1189	1	0	0	·7056
	15	0	0	10	·4393	1	0	0	·7531
	30	0	0	10	·7604	1	0	0	·7992
	45	0	0	11	·0808	1	0	0	·8474
9		0	0	11	·4034	1	0	0	·8971
	15	0	0	11	·7259	1	0	0	·9482
	30	0	1	0	·0485	1	0	1	·0008
	45	0	1	0	·3696	1	0	1	·0548
10		0	1	0	·6936	1	0	1	·1088
	15	0	1	1	·0176	1	0	1	·1664
	30	0	1	1	·8416	1	0	1	·2262
	45	0	1	1	·6692	1	0	1	·2859
11		0	1	1	·9954	1	0	1	·3476
	15	0	1	2	·3215	1	0	1	·4106
	30	0	1	2	·6484	1	0	1	·4750
	45	0	1	2	·9760	1	0	1	·5410
12		0	1	3	·3036	1	0	1	·6085
	15	0	1	3	·6326	1	0	1	·6775
	30	0	1	3	·9617	1	0	1	·7481
	45	0	1	4	·2914	1	0	1	·8202
13		0	1	4	·6219	1	0	1	·8939
	15	0	1	4	·9538	1	0	1	·9691
	30	0	1	5	·2857	1	0	2	·0459
	45	0	1	5	·6178	1	0	2	·1242
14		0	1	5	·9496	1	0	2	·2042
	15	0	1	6	·2858	1	0	2	·2857
	30	0	1	6	·6192	1	0	2	·3638
	45	0	1	6	·9576	1	0	2	·4535
15		0	1	7	·2888	1	0	2	·5399
	15	0	1	7	·6294	1	0	2	·6338
	30	0	1	7	·9670	1	0	2	·7174
	45	0	1	8	·3062	1	0	2	·8087
16		0	1	8	·6456	1	0	2	·9015
	15	0	1	8	·9858	1	0	2	·9961
	30	0	1	9	·3271	1	0	3	·0443
	45	0	1	9	·6695	1	0	3	·1902
17		0	1	10	·0126	1	0	3	·2898
	15	0	1	10	·3560	1	0	3	·3911
	30	0	1	10	·7003	1	0	3	·4941
	45	0	1	11	·0472	1	0	3	·5988
18		0	1	11	·3942	1	0	3	·7053
	15	0	1	11	·6220	1	0	3	·8135
	30	0	2	0	·0905	1	0	3	·9234
	45	0	2	0	·4204	1	0	4	·0352
19		0	2	0	·7916	1	0	4	·1487
	15	0	2	1	·1435	1	0	4	·2640

ANGLE.		BASE.				HYPOTHENUSE.			
Deg.	Min.	Fath.	Feet.	Ins.	Decimals.	Fath.	Feet.	Ins.	Decimals.
19	30	0	2	1	·4965	1	0	4	·3811
	45	0	2	1	·8506	1	0	4	·5000
20		0	2	2	·2058	1	0	4	·6208
	15	0	2	2	·5622	1	0	4	·7434
	30	0	2	2	·9197	1	0	4	·8679
	45	0	2	3	·2783	1	0	4	·9942
21		0	2	3	·6262	1	0	5	·1224
	15	0	2	3	·9993	1	0	5	·2526
	30	0	2	4	·3615	1	0	5	·3846
	45	0	2	4	·7251	1	0	5	·5186
22		0	2	5	·0899	1	0	5	·6545
	15	0	2	5	·4560	1	0	5	·7924
	30	0	2	5	·8234	1	0	5	·9323
	45	0	2	6	·1921	1	0	6	·0741
23		0	2	6	·5622	1	0	6	·2179
	15	0	2	6	·9336	1	0	6	·3638
	30	0	2	7	·3065	1	0	6	·5117
	45	0	2	7	·6807	1	0	6	·6617
24		0	2	8	·0565	1	0	6	·8138
	15	0	2	8	·4336	1	0	6	·9679
	30	0	2	8	·8123	1	0	7	·1242
	45	0	2	9	·1924	1	0	7	·2826
25		0	2	9	·5741	1	0	7	·4432
	15	0	2	9	·9574	1	0	7	·6059
	30	0	2	10	·3422	1	0	7	·7708
	45	0	2	10	·7287	1	0	7	·9380
26		0	2	11	·1167	1	0	8	·1073
	15	0	2	11	·5065	1	0	8	·2789
	30	0	2	11	·8979	1	0	8	·4528
	45	0	3	0	·2910	1	0	8	·6290
27		0	3	0	·6858	1	0	8	·8075
	15	0	3	1	·0824	1	0	8	·9883
	30	0	3	1	·4808	1	0	9	·1714
	45	0	3	1	·8810	1	0	9	·3571
28		0	3	2	·2831	1	0	9	·5450
	15	0	3	2	·6870	1	0	9	·7354
	30	0	3	3	·0928	1	0	9	·9283
	45	0	3	3	·5005	1	0	10	·1232
29		0	3	3	·9102	1	0	10	·3212
	15	0	3	4	·3219	1	0	10	·5220
	30	0	3	4	·7356	1	0	10	·7251
	45	0	3	5	·1514	1	0	10	·9303
30		0	3	5	·5692	1	0	11	·1384
	15	0	3	5	·9892	1	0	11	·3494
	30	0	3	6	·4112	1	0	11	·5625
	45	0	3	6	·8355	1	0	11	·7788
31		0	3	7	·2620	1	0	11	·9976
	15	0	3	7	·6907	1	1	0	·2192
	30	0	3	8	·1216	1	1	0	·4436
	45	0	3	8	·5550	1	1	0	·7008
32		0	3	8	·9906	1	1	0	·9008
	15	0	3	9	·4286	1	1	1	·1338
	30	0	3	9	·8691	1	1	1	·3696
	45	0	3	10	·3119	1	1	1	·6084
33		0	3	10	·7578	1	1	1	·8501
	15	0	3	11	·2053	1	1	2	·0949
	30	0	3	11	·6558	1	1	2	·3427
	45	0	4	0	·1088	1	1	2	·5937
34		0	4	0	·5646	1	1	2	·8477
	15	0	4	0	·9931	1	1	3	·1049
	30	0	4	1	·4842	1	1	3	·3653
	45	0	4	1	·9482	1	1	3	·6289
35		0	4	2	·4149	1	1	3	·8958
	15	0	4	2	·8846	1	1	4	·1660
	30	0	4	3	·3571	1	1	4	·4394
	45	0	4	3	·8326	1	1	4	·7165
36		0	4	4	·3111	1	1	4	·9969
	15	0	4	4	·7914	1	1	5	·2808
	30	0	4	5	·2772	1	1	5	·6819
	45	0	4	5	·5650	1	1	5	·8591
37		0	4	6	·2559	1	1	6	·1538
	15	0	4	6	·7501	1	1	6	·4520
	30	0	4	7	·2475	1	1	6	·7540
	45	0	4	7	·7483	1	1	7	·0597

ANGLE.		BASE.				HYPOTHENUSE.			
Deg.	Min.	Fath.	Feet.	Ins.	Decimals.	Fath.	Feet.	Ins.	Decimals.
38		0	4	8	·2526	1	1	7	·3693
	15	0	4	8	·7602	1	1	7	·6831
	30	0	4	9	·2884	1	1	8	·0000
	45	0	4	9	·7861	1	1	8	·3214
39		0	4	10	·3044	1	1	8	·6467
	15	0	4	10	·8265	1	1	8	·9761
	30	0	4	11	·3542	1	1	9	·3096
	45	0	4	11	·8818	1	1	9	·6473
40		0	5	0	·4152	1	1	9	·9893
	15	0	5	0	·9525	1	1	10	·0956
	30	0	5	1	·4938	1	1	10	·6863
	45	0	5	2	·0392	1	1	11	·0413
41		0	5	2	·5886	1	1	11	·4009
	15	0	5	3	·1420	1	1	11	·7651
	30	0	5	3	·7002	1	2	0	·1338
	45	0	5	4	·2624	1	2	0	·5049
42		0	5	4	·8291	1	2	0	·8855
	15	0	5	5	·4002	1	2	1	·2686
	30	0	5	5	·9758	1	2	1	·6566
	45	0	5	6	·5705	1	2	2	·0496
43		0	5	7	·1411	1	2	2	·4476
	15	0	5	7	·7308	1	2	2	·8507
	30	0	5	8	·3254	1	2	3	·2591
	45	0	5	8	·9250	1	2	3	·6727
44		0	5	9	·5296	1	2	4	·0918
	15	0	5	10	·1393	1	2	4	·5163
	30	0	5	10	·7542	1	2	4	·9463
	45	0	5	11	·3744	1	2	5	·3820
45		1	0	0	·0000	1	2	5	·8234
	15	1	0	0	·6311	1	2	6	·2706
	30	1	0	1	·2677	1	2	6	·7237
	45	1	0	1	·9101	1	2	7	·1828
46		1	0	2	·5852	1	2	7	·6481
	15	1	0	3	·2122	1	2	8	·1195
	30	1	0	3	·8722	1	2	8	·5973
	45	1	0	4	·5382	1	2	9	·0814
47		1	0	5	·2105	1	2	9	·5721
	15	1	0	5	·8892	1	2	10	·0694
	30	1	0	6	·5742	1	2	10	·5735
	45	1	0	7	·2658	1	2	11	·0844
48		1	0	7	·9641	1	2	11	·6023
	15	1	0	8	·6692	1	3	0	·1273
	30	1	0	9	·3812	1	3	0	·6596
	45	1	0	10	·1003	1	3	1	·1991
49		1	0	10	·8265	1	3	1	·7462
	15	1	0	11	·5601	1	3	2	·3009
	30	1	1	0	·3012	1	3	2	·8634
	45	1	1	1	·0498	1	3	3	·4337
50		1	1	1	·8062	1	3	4	·0122
	15	1	1	2	·5699	1	3	4	·5987
	30	1	1	3	·3430	1	3	5	·1936
	45	1	1	4	·1236	1	3	5	·7970
51		1	1	4	·9126	1	3	6	·4091
	15	1	1	5	·7101	1	3	7	·0300
	30	1	1	6	·5164	1	3	7	·6599
	45	1	1	7	·3316	1	3	8	·2990
52		1	1	8	·1560	1	3	8	·9474
	15	1	1	8	·9893	1	3	9	·6053
	30	1	1	9	·8322	1	3	10	·2729
	45	1	1	10	·6848	1	3	10	·9505
53		1	1	11	·5472	1	3	11	·6381
	15	1	2	0	·4197	1	4	0	·3360
	30	1	2	1	·3024	1	4	1	·0445
	45	1	2	2	·1956	1	4	1	·7636
54		1	2	3	·0995	1	4	2	·4937
	15	1	2	4	·0143	1	4	3	·2350
	30	1	2	4	·9403	1	4	3	·9876
	45	1	2	5	·8776	1	4	4	·7520
55		1	2	6	·8267	1	4	5	·5282
	15	1	2	7	·7876	1	4	6	·3165
	30	1	2	8	·7606	1	4	7	·1172
	45	1	2	9	·7458	1	4	7	·9306

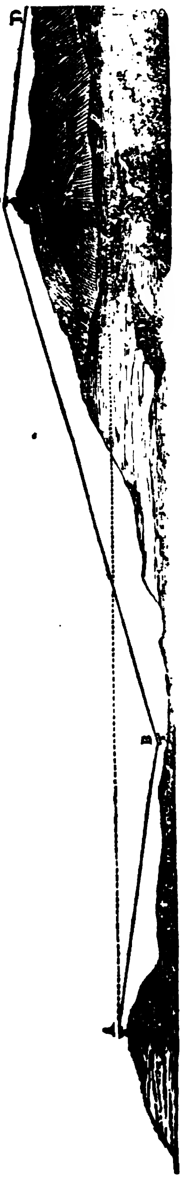
ANGLE.		BASE.				HYPOTHENUSE.			
Deg.	Min.	Fath.	Feet.	Ins.	Decimals.	Fath.	Feet.	Ins.	Decimals.
56		1	2	10	·7444	1	4	8	·7570
	15	1	2	11	·7556	1	4	9	·6966
	30	1	3	0	·7801	1	4	10	·4497
	45	1	3	1	·8182	1	4	11	·3165
57		1	3	2	·8703	1	5	0	·1976
	15	1	3	3	·9365	1	5	1	·0932
	30	1	3	5	·0174	1	5	2	·0034
	45	1	3	6	·1131	1	5	2	·9287
58		1	3	7	·2241	1	5	3	·8697
	15	1	3	8	·3507	1	5	4	·8265
	30	1	3	9	·4933	1	5	5	·7994
	45	1	3	10	·6523	1	5	6	·7890
59		1	3	11	·7281	1	5	7	·7955
	15	1	4	1	·0211	1	5	8	·8194
	30	1	1	2	·2317	1	5	9	·8612
	45	1	4	3	·4604	1	5	10	·9212
60		1	4	4	·7077	2	0	0	·0000

THIRD TABLE. BASE RADIUS, ONE FATHOM.



THIRD TABLE. BASE RADIUS, ONE FATHOM.

ANGLE.	HYPOTHENUSE.				PERPENDICULAR.			
Degrees.	Fath.	Feet.	Ins.	Decimals	Fath.	Feet.	Ins.	Decimals.
1	57	1	9	·50554	57	1	8	·87726
2	28	3	11	·06698	28	3	9	·81022
3	19	0	7	·72726	19	0	5	·84186
4	14	2	0	·16226	14	1	9	·64795
5	11	2	10	·10734	11	2	6	·96374
6	9	3	4	·80760	9	3	1	·03424
7	8	1	2	·79665	8	0	10	·39294
8	7	1	1	·34135	7	0	8	·30662
9	6	2	4	·25663	6	1	10	·59011
10	5	4	6	·63148	5	4	0	·33229
11	5	1	5	·34070	5	0	10	·40789
12	4	4	10	·30087	4	4	2	·73337
13	4	2	8	·06963	4	1	11	·86626
14	4	0	9	·61672	4	0	0	·77622
15	3	5	2	·18664	3	4	4	·70766
16	3	3	9	·21278	3	2	11	·09384
17	3	2	6	·26186	3	1	7	·50139
18	3	1	4	·99690	3	0	5	·59321
19	3	0	5	·15185	2	5	5	·10318
20	2	5	6	·51392	2	4	5	·81837
21	2	4	8	·91082	2	3	7	·56641
22	2	4	0	·20164	2	2	10	·20626
23	2	3	4	·26994	2	2	1	·62137
24	2	2	9	·01872	2	1	5	·71465
25	2	2	2	·36651	2	0	10	·40450
26	2	1	8	·24438	2	0	3	·62187
27	2	1	2	·59363	1	5	9	·30796
28	2	0	9	·36392	1	5	3	·41231
29	2	0	4	·51190	1	4	9	·89144
30	2	0	0	·00000	1	4	4	·70766
31	1	5	7	·79549	1	3	11	·82812
32	1	5	3	·86975	1	3	7	·22408
33	1	5	0	·19765	1	3	2	·87028
34	1	4	8	·75699	1	2	10	·74439
35	1	4	5	·52817	1	2	6	·82666
36	1	4	2	·49371	1	2	3	·09950
37	1	3	11	·63809	1	1	11	·54722
38	1	3	8	·94738	1	1	8	·15579
39	1	3	6	·40913	1	1	4	·91260
40	1	3	4	·01211	1	1	1	·80626
41	1	3	1	·74622	1	0	10	82652
42	1	2	11	·60231	1	0	7	·96410
43	1	2	9	·57201	1	0	5	·21055
44	1	2	7	·64807	1	0	2	·55818
45	1	2	5	·82388	1	0	0	·00000
46	1	2	4	·09178	0	5	9	·52959
47	1	2	2	·44758	0	5	7	·14108
48	1	2	0	·88555	0	5	4	·82909
49	1	1	11	·40094	0	5	2	·58864
50	1	1	9	·98932	0	5	0	·41517
51	1	1	8	·61669	0	4	10	·30445
52	1	1	7	·36931	0	4	8	·25256
53	1	1	6	·15377	0	4	6	·25589
54	1	1	4	·99689	0	4	4	·31106
55	1	1	3	·89577	0	4	2	·41494
56	1	1	2	·84768	0	4	0	·56461
57	1	1	1	·85016	0	3	10	·75735
58	1	1	0	·90084	0	3	8	·99060
59	1	0	11	·99760	0	3	7	·26196
60	1	0	11	·13844	0	3	5	·56922



LEVELLING.

Rule.—Add all the perpendiculars together for the base line or horizontal distance, and subtract the bases made by the angles of elevation and depression one from the other, for the perpendicular or difference of height.*

EXAMPLE.

Being required to level an irregular piece of ground, I measured in a S. W. direction 64 yards from A to B, on an angle of depression 9° 45′; from this station I measured 120 yards from B to C, in the same cardinal direction, on an angle of elevation 16° 30′; and from thence to the extent of the ground the line on the same course measured 44 yards from C to D, and the angle of depression 7°: required the base line or horizontal distance from the place where the levelling was begun, to the point where it was ended; also how much higher or lower the ground is at the place where the operation terminated, than where it commenced.

Perpendiculars.

	ft.	in.		fath.		ft.	in.
∠ 9° 45′ =	5	10·96004	×	32	=	189	2·72128
∠ 16° 30′ =	5	9·03502	×	60	=	345	2·10120
∠ 7° 0′ =	5	11.46333	×	22	=	131	0·19326
					3)	665	5·01574
					A E	221 yds. 2 ft. 5 in.	

* The altitudes of irregular hills are generally ascertained by the assistance of a spirit level and perpendicular poles, and if the ground rise and descend alternately, the differences between the heights of the poles are added when ascending, and subtracted when descending, in order to determine the different elevations and depressions of the ground: the foregoing rule and method will be found far more correct and masterly, remembering always that the height of the instrument be accounted for, which may easily be done by taking the observation from a staff or target the same height as the instrument.

Bases.

Elevation. Depression.	ft.	in	fath.	ft.	in
∠9° 45′ =	1	0·19316 × 32 =		32	6·18112
∠7° 0′ =	0	8·77459 × 22 =		18	1·04098
				50	7·22210
∠16° 30′ =	1	8·44910 × 60 =		102	2·94600
			3)	51	7·72390
			E D	17 yds. 0 ft.	$7\frac{1}{2}$ in.

ANSWER.

	yds.	ft.	in.
Horizontal distance A E	221	2	5
Elevation E D . . .	17	0	$7\frac{1}{2}$

HORIZONTAL OR TRAVERSE DIALLING.

Plane sailing in navigation, and horizontal dialling in mining, are nothing more than the practice of right angled trigonometry, calling the hypothenuse the distance, the perpendicular the difference of latitude, the base the departure, and the angle opposite the base the course: consequently any range of dialling, however complicated and extensive, may be reduced into a single triangle, the perpendicular of which will either be the east and west, or north and south line, according to the main direction or bearing of the work; the hypothenuse will be the actual length of the dialling in a right line from the point of setting out to the termination; the base will be the distance the terminating point will fall right or left of the perpendicular; and the angle made by the hypothenuse with the perpendicular, will be the final course or direction of the work.

The variation of the compass is an evident and important cause of discrepancies occurring in mine surveys made at different dates, particularly when, as is too often the case, the old diallers omitted to show the then actual variations on their compass points. To determine at any time the variation of the compass involves the necessity of determining a meridian line, an operation of some difficulty, which may, I think, be dispensed with by the following method:—In making a true survey of a mine, let the dialler, with the same instrument he uses underground, run a north and south line on the surface, in any convenient part of the sett, marking the extremities by well-fixed points, such as iron pins let into stone. These points, being marked on the plan, will form a datum north and south line, with which at any time a dialler can compare his instruments, and make the necessary allowance for change of variation. If at any time either of the points should become liable to be covered with deads or other works, it would only be necessary to run a parallel line in a less obstructed locality, and mark the same on the plan. In adding fresh dialling to an old plan on which no variation is marked, select two points most likely to have been carefully laid down

such as the centres of two shafts, &c.; then, by comparing their bearing as laid down with the bearing actually taken on the ground, the dialler would determine the amount of variation between the date of the plan and the date of his own work, and could, therefore, lay down and put on the plan a datum north and south line. In dialling an underground level, if there be reason to suppose that the needle is affected by any local attraction, it would be sufficient, supposing such local attraction to be continuous, to dial the reverse way, taking the same stations, and the mean of each two observations. If the local attraction, however, is not continuous, but merely exists at certain points, the only correction possible would be repeating the observations, and changing each time the position of the instrument.

When a point (such as the position of a proposed shaft, &c.) has been fixed underground, and it is required to determine the same on the surface, the common plan with most captains is to repeat the observations; in fact, to make on the surface a copy of their underground dialling. Now, this is objectionable, inasmuch as in repeating a multiplicity of angles there is always danger of error, and the surface, being often rugged or hilly, is not adapted to the instrument commonly used. It would, of course, be easy to determine trigonometrically the point required by one observation, by reducing the angles taken, exactly as a log-book at sea might be reduced; but I think that by laying down the underground work on a good scale on paper the same result might be obtained, in a manner much simpler and more easily understood by those unaccustomed to mathematical calculations. A few dials are read to less than half a degree, a comman brass protractor, such as is found in cheap drawing instrument cases, would ensure all necessary accuracy; this, and a box-wood scale, any intelligent miner would soon acquire the use of, and a very little knowledge of drawing would enable him to construct a cardboard protractor of any size he might deem convenient. The method of plotting, instead of calculating reduced dialling is, I am convinced from practice, not only simpler, but more expeditious, less liable to error, and much more easily checked than effecting the same trigonometrically. At the same time, should any prefer the latter method, the natural sines and cosines for degrees and half degrees from 0 to 45, which could be easily written on a small card, are all that is required.

It therefore follows, that the general practice of repeating or retracing a course of underground dialling on the surface may be avoided, and thereby the difficulties and dangers arising from obstructions, irregular ground, and the attraction of the magnet by iron, which always abounds in the vicinity of a mine, be done away.

What is said of Mercator's sailing may, in the chief respect, be applied to horizontal dialling, viz.: "It is the art of finding

on a plane surface the motion of a ship upon any assigned course by the compass, which shall be true in latitude, longitude, and distance sailed;" and certainly this includes the whole theory and practice of navigation; and if any method could be devised for measuring a ship's course and distance truly, nothing would be wanting:—also in dialling, it is only required to find a method for reducing the various windings and angles of a level or adit into a right line, and discovering the real extent and direction of that line, to complete the art.

But not to occupy the reader's time in telling him what he well knows already, we shall proceed to introduce the process for obtaining the length and bearing of a course of traverse dialling by the trigonometrical tables.

The first thing to be attended to is the statement of the work, or so placing the drafts that there may be no confusion in the operation, and that the perpendiculars and bases may fall on their proper sides.

In order to succeed in this essential matter, which may be considered the foundation of the work, note on which cardinal point the main direction of your dialling runs, whether east, west, north, or south, and reckon off your degrees right or left from that line: thus—if your dialling runs easterly or westerly, let the equator, or east and west line, be the point for numbering off your angles—if northerly or southerly, the meridian or north and south line; consequently this line will be the perpendicular of every triangle in the operation that comes within the sweep of half the circle, or 180°; and should any of the drafts return beyond the north or south points, or exceed 90° right or left of the east point, then the angle must be counted from the west toward the north or south, as the draft may happen to incline.

This being done, it is evident that on a course of east and west dialling, the bases north and bases south must be subtracted one from the other, and the remainder will be the departure or base line, north or south as the dialling may have prevailed on this or that side, and if any of the drafts have gone westerly, then the perpendiculars west must be subtracted from the perpendiculars east, for the real length of the perpendicular; but if the dialling has prevailed most in a westerly direction, the perpendicular will lie on that side: in short, as a matter of course, either for the difference of latitude, or rather difference of longitude in this case (the perpendicular), or for the departure (the base), the lesser number must be taken from the greater, and the differences will show the sides on which the operation lies.

This process must all be performed by the first table, where the hypothenuse is given, because in every case the actual measured line will be the longest side of the triangle, and after stating the work, as before directed, take out the numbers standing against the given angles in the table and multiply them respectively by

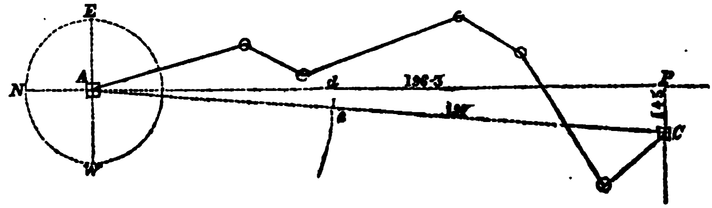
the length of the hypothenuse, reduced into fathoms and parts (if any), and place them into their proper positions until the whole has been calculated; then take the sum of the bases north and south one from the other, and the sum of the perpendiculars east and west one from the other, the perpendicular remainders will show the east and west line, and the bases the distance the dialling has extended north or south of that line.

The work is now brought to that case where the difference of latitude and departure are given to find the course and distance, and in order to avoid the necessity of introducing extensive and intricate tables, used by navigators for this purpose, we shall have recourse to one simple act of instrumental operation, and as two sides of the triangle are given, the thing may be quickly and safely performed; thus—draw the base the given length by a scale of equal parts, raise the perpendicular on one end of the base (and of course at right angles therewith), and mark off the given length, draw the hypothenuse, and the triangle will be complete: then, by the same scale, measure the hypothenuse, and it will be the actual length of the dialling in a right line, from beginning to end; then, with a protractor or scale of chords, measure the angle opposite the departure or base, and it will be the true course, bearing, or direction of the extreme points.

The degrees on the miner's compass are generally graduated from 1 to 360, and are figured toward the left hand, consequently 90° stands at the west point, 180° at south, 270° at the east, and ends with 360° at the north; and when the same course is to be pursued, that is, when the angles are to be taken and the drafts measured again, there will be no necessity for finding the real direction of the line, for as the sights are always fixed, the dialler need only be careful to observe that the needle stands at the same degree as in the original course; but when the operation is to be plotted or trigonometrically proved, there will be a necessity for ascertaining the actual bearing of every draft in the work, and this may be done by the following rule.

RULE.—SIGHTS FIXED NORTH AND SOUTH.

When the needle rests on any degree		*The direction of the sights or course of the dialling will be*
From 1 to 90 N. to W.	....	E. of N. Comp. N. of E.
From 90 to 180 W. to S.	....	S. of E. Comp. E. of S.
From 180 to 270 S. to E.	....	W. of S. Comp. S. of W.
From 270 to 360 E. to N.	....	N. of W. Comp. W. of N.



EXAMPLE I.

It is required to sink a perpendicular shaft on the end of a level whose angles and drafts are measured as follows, viz.:

				ft.	in.		f.	ft.	in.
∠16°	30′	E.	of S.	53	6	or	8	5	6
∠26°	0′	W.	of S.	22	11	or	3	4	11
∠19°	0′	E.	of S.	58	0	or	9	4	0
∠34°	30′	W.	of S.	21	6	or	3	3	6
∠57°	30′	W.	of S.	53	8	or	8	5	8
∠39°	30′	E.	of S.	29	10	or	4	5	10

What distance is the end C (in the annexed plate), where the dialling was finished, from the engine shaft A where the dialling was begun, and what is the bearing of the line AC, or how many degrees are contained in the angle B A C?

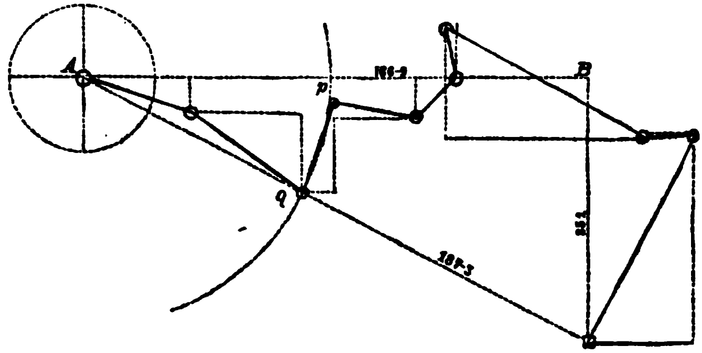
OPERATION.

Bases.

	ft.	in.	fath.	ft.	in.	ft.	in.
E. of S. 16½ =	1	8·44910 ×	8	5	6 =	15	2·33790
W. of S. 26° =	2	7·56272 ×	3	4	11 =	10	0·53916
E of S. 19° =	1	11·44091 ×	9	4	0 =	18	10·58864
W. of S. 34°½ =	3	4·78125 ×	3	3	6 =	12	2·13235
W. of S. 57°½ =	5	0·72418 ×	8	5	8 =	45	3·18762
E. of S. 39°½ =	3	9·79763 ×	4	5	10 =	18	11·55815

	ft.	in.
Sum of bases W. of S.	67	5.85913
Sum of bases E. of S.	53	0·46469
Base or departure Westerly B C =	14	5·37444

Scale 40 feet to an inch.



Perpendiculars.

deg.	ft.	in.	fath.	ft.	in.	ft.	in.
∠16½ =	5	9·03508 ×	8	5	6 =	51	8·56298
∠26 =	5	4·71317 ×	3	4	11 =	20	7·16851
∠19 =	5	8·07734 ×	9	4	0 =	54	10·96606
∠34½ =	4	11·33709 ×	3	3	6 =	17	8·69417
∠57½ =	3	2·68557 ×	8	5	8 =	28	10·05016
∠39½ =	4	7·55697 ×	4	5	10 =	23	0·04485
Perpendicular or diff. of latitude, A B						196	3·51605

THEN—BY CONSTRUCTION.

Draw two lines at right angles, as A B and B C, and of an indefinite length, take 196 feet, 3¼ inches, in your compasses from a scale of equal parts, and with one foot in the right angle B, point off the distance B A for the perpendicular. Again take 14 feet, 5½ inches from the same scale, and apply it to the other line B C for the base; draw the hypothenuse to join A C, which by the same scale will be found to measure 197 feet.

FOR THE ANGLE.

With the chord of 60° in your compasses and centre A, describe an arc *e d* cutting A B and A C in *d* and *e*; then take the distance *e d* in your compasses, and setting one foot on the brass pin at the beginning of the chords on your scale, observe how many degrees the other foot reaches to, which will be 4° 15′ for the arc *e d* or angle B A C.

ANSWER.

197 feet, on an angle of 4° 15′ west of south.

EXAMPLE II.

Given the following course of traverse dialling, viz.:

Degrees at which the needle stood on the outer circle of the dial.				ft.	in.		fath.	ft.	in.
162°	= ∠18°	0′	S. of E.	36	0	or	6	0	0
143°¾	= ∠36°	15	S. of E.	44	4	or	7	2	4
16°½	= 73°	30′	N. of E.	30	9	or	5	0	9
257°¼	= ∠12°	45′	S. of E.	28	6	or	4	4	6
45°	= ∠45°	0′	N. of E.	17	10	or	2	5	10
7°¾	= ∠82°	15′	N. of W.	15	3	or	2	3	3
152°½	= ∠27°	30′	S. of E.	72	0	or	12	0	0
87°½	= ∠ 2°	30′	N. of E.	16	0	or	2	4	0
204°½	= ∠65°	30′	S. of W.	73	0	or	12	1	0

Required the distance and bearing of the extreme points A C.

OPERATION.

Bases southerly.

deg.			ft.	in.		fath.	ft.	in.		ft.	in.
18	0′	=	1	10·24923	×	6	0	0	=	11	1·49523
36	15′	=	3	6·57429	×	7	2	4	=	26	2·57669
12	45′	=	1	3·29021	×	4	4	6	=	6	3·44849
27	30′	=	2	9·24590	×	12	0	0	=	33	29·5080
65	30′	=	5	5·51721	×	12	1	0	=	66	5·12605
										143	3·59725

Bases northerly.

deg.			ft.	in.		fath.	ft.	in.		ft.	in.
73	30′	=	5	9·03502	×	5	0	9	=	29	5·80446
45	0′	=	4	2·91169	×	2	5	10	=	12	7·14507
82	15′	=	5	11·34234	×	2	3	3	=	15	1·33685
2	30′	=	0	3·14060	×	2	4	0	=	0	8·37150
										57	10·65790

		ft.	in.
From bases southerly	=	143	3·59725
Subtract bases northerly	=	57	10·65790
Departure B C		85	4·93935

Perpendiculars easterly.

deg.			ft.	in.		fath.	ft.	in.		ft.	in.
18	0′	=	5	8·47607	×	6	0	0	=	84	2·85649
36	15′	=	4	10·06401	×	7	2	4	=	35	9·02851
73	30′	=	1	8·44910	×	5	0	9	=	8	10·80163
12	45′	=	5	10·22464	×	4	4	6	=	27	9·56704
45	0′	=	4	2·91169	×	2	5	10	=	12	7·14507
27	30′	=	5	3·86478	×	12	0	0	=	63	10·37736
2	30′	=	5	11·93147	×	2	4	0	=	15	11·81724
										199	1·59327

Perpendiculars westerly.

deg.			ft.	in.		fath.	ft.	in.		ft.	in.
82	15′	=	0	9·70926	×	2	3	3	=	2	0·67815
65	30′	=	2	5·85791	×	12	1	0	=	30	3·27124
										32	3·94939

		ft.	in.
From perpendiculars east	=	199	1·59327
Subtract perpendiculars west	=	32	3·94939
	A B	166	9·64388

	ft.	in.
Perp. or east and west line, A B	166	9·64388
Base south of east C B	85	4·93935

Then by construction (as before) the hypothenuse A C will be found 187 feet, 3 inches, and the angle *p q* 27 degrees, south of east.

THE PRACTICAL MINER'S GUIDE.—PART II.

INTRODUCTION.

Several years have elapsed since "The Practical Miner's Guide" was sent into the world, and the author is constrained to acknowledge that his extensive practice and experience, in almost every branch of mining, during that long period, has not enabled him to discover where any important improvement can be made in that work. The *additions* in the present volume are comprised in merely extending the principles originally laid down, and practically applying the mathematical tables and rules to more difficult, complicated, and momentous subterranean surveys; for it may be remarked, without subjecting ourselves to the charge of arrogancy, that the *light* thrown on the mining world by this publication has contributed towards expanding the minds of practical men generally, and qualifying them for pursuing and carrying out the scientific and demonstrative principles to the utmost extent of their difficult and highly important operations.

During the last five years the author commenced a correspondence on mine surveying in the "Mining Journal," with a view of rendering a lasting benefit to the mining interest, by exposing the imperfection of the old methods of dialling, by *tracing*, *pegging*, or mechanical repetition, and showing the vast superiority of the trigonometrical system in every point of view. This at-

tempt brought on a most extensive controversy, and many of "the old school" arose and came forward to advocate the old practice; but, as if ashamed of the cause they had espoused, they were, almost to a man, anonymous writers.

The unprejudiced and investigating part of the community honored me, or rather the system I defended, with their able support, and rallied around my standard. The defeat of our opponents was complete, even before we attempted to apply the infallible test of *experimental operation.* Reason and historical proof had thrown them down; but when we brought forward problems, in the shape of actual surveys, and challenged them to furnish the true answers, they crept out of the field, and not one of them was heard of after that interesting, beneficial and satisfactory investigation was introduced. Nearly all the problems that appear in this supplement were publicly brought forward by the author on this occasion, and of course underwent a rigid and extensive scrutiny; and, so far from any error appearing, the truth of the calculation and perfection of the system was demonstrated by exact corresponding solutions being publicly recorded from persons residing in England, Ireland, and Wales.

It will be seen, in the preface to the first edition of this work, that I called public attention to the great injury done to mining by the bad practice of surveying or dialling then in general use; but as at that time there was no work written on the subject, there was an excuse for the disastrous errors that took place then, that does not now exist; and the mine agent who cannot now *prove* all his dialling operations, before a single stroke has been struck, ought not to presume to make the attempt; and certainly it behoves directors, managers, and shareholders in mines, to test the abilities of those agents or captains who profess to be competent to undertake the momentous work of subterraneous surveying, by requiring them to give mathematical solutions to a series of practical questions on the subject; and not, as is too often the case, proving their incapacity by some fearful error that they have committed, occasioning serious injury to the mine, great delay, and an extra cost of hundreds of pounds to the proprietors. And let it be understood, that *proof* cannot be obtained by the old method of dialling; that is, by tracing or repeating at the surface the draf tstaken underground. This was fully demonstrated in the course of the late controversy, both argumentative and practically. One convincing case was brought forward, and confirmed, that occurred several years ago. It was required to find the point at surface for sinking a shaft to meet a rise that had been commenced at the adit level. This was certainly a very plain and easy job under a good system, but it presented insurmountable difficulties under the old practice. The shaft was set to a pair of eight men, and the captains proceeded to *dial* and *peg* to ascertain the true point. The first dialler fixed his terminating

peg on a certain spot, and the next dialler's peg occupied another position; and, the history of the case is, that four agents were constantly occupied two or three weeks about this job, without being able to ascertain the true place for the shaft, which a competent man would have determined and proved in a few hours. At the close they had a plantation of pegs occupying an area of several square fathoms; and the manager seeing it hopeless to expect *certainty* from such an *uncertain* practice, and tired of waiting and wasting any more time, proceeded to make the best of a bad matter, by lining out the shaft in the place where the pegs appeared to stand thickest! and the consequence was, a serious error of some feet in the holing.

Now, by introducing this affair, our design is not to impeach *men*: it is the *practice* or usage that we condemn and expose, in order that it may be discountenanced and rejected, and thereby an incalculable benefit be conferred on metallic mining.

TRAVERSE DIALLING.

It is well known that our mine agents or captains have almost to a man been selected from the "ranks," and have been brought up as working miners from their youth; and the best judges admit the propriety and even necessity of this regulation, in order that they should be competent to fix the value or fair price for working a tut-work bargain, or tribute pitch, and possess a thorough knowledge of underground operations. This being admitted, we must conclude, that in general their education has been much limited; and, therefore, in writing for their assistance, although there may be some exceptions, we would accommodate ourselves to the lowest capacity, so that the young aspiring miner may not be discouraged from prosecuting his incumbent and laudable studies, and qualifying himself for performing the high and paramount duties of a mine agent with credit to himself, and advantage to his employers and his country.

Before this work was published, it is questionable whether a mining traverse had ever been trigonometrically solved in this country; and, consequently, in order to simplify the matter, the instructions given for finding the ultimatum of a course of dialling was by construction or instrumental operation; but as we believe our students are generally prepared to advance a step, we shall now recommend and show the more excellent way of performing the whole by computation, or by figures.

The trigonometrical method of working a course of dialling reduces the whole, however numerous and diversified, into two numbers; for the four columns of easting, westing, northing, and southing being added up separately, and then the lesser deducted from the greater of the opposite cardinal points, reduces the whole into two numbers, forming the base and perpendicular of the great triangle, and are necessarily right angle cardinal bear-

ings, such as easting and southing, or northing and westing, as the case may be; and our next and last operation is to find the hypothenuse and angle corresponding with these two sides, which hypothenuse and angle is the final line, or course of the survey.

EXAMPLE.

A traverse has been worked, the columns added up, and the westing subtracted from the easting, showing the excess of easting to be 346 feet; and the southing subtracted from the northing, the difference proved the excess of northing, 419 feet 5 inches.

OPERATION.

Find the hypothenuse by square root.

Rule.—Add the sum of the squares of the two sides together, and extract the square root of their sum.

```
      346          419·4
      346          419·4
     ----          -----
     2076         16776
    1384          37746
   1038           4194
   ------        16776
   119716        ----------
                 175896.36
                 119716
                 ----------
                 29561236 (543·7
                 25                 12
                 ----              ----
            104) 456                8·4
                 416
                 ------
           1083) 4012
                  3249
                 ------
          10867)  76336
                  76069
                  -----
                    267
                  -----

             ft. in
 Answer Hyp. 543  8
```

Find the angle by proportion.

```
   ft. in.        ft.              ft.
If 419  5 gives  346  what will    6  give?
    12            12              12
  ----          ----              --
  5033          4152              72
                  72
                ----
                8304
              29064
              ------           in.      ft.  in.
        5033) 298944 (59·39  or  4   11·39
              25165
              ------
               47294
               45297
               ------
                19970
                15099
                ------
                 48710
                 45297
                 ------
                  4413
                 ------
```

Then by inspection in the second table, page 79, this quotient of 4 feet 11·39 inches will be found standing opposite 39° 30′, which is the bearing, or sum of the angle opposite the shortest side of the great triangle.

ANSWER.

Hypothenuse, or direct length from beginning to end, 543 feet 8 inches. Bearing, or direction from beginning to end, 39° 30′ east of north.

REMARKS.

In carrying out this system practically, after we have laid down this grand or final line at surface, and fixed a mark at the extreme end of the line which has been measured off from the starting point, 543 feet 8 inches on the bearing, 39° 30′ east of north, (or 50° 30′ north of east, the complement,) we are furnished with a double means of proving if this length and angle has been correctly laid down, by measuring off, due north, 419 feet 5 inches from the start, and then placing the theodolite, or dial, on the end of that line, and measuring off due east 346 feet; consequently, if the whole has been well done, the last mark will exactly agree in both cases. Or should the ground be more favorable, we may avail ourselves of the convenience of laying off the east line first, and the north line last, which will bring us to the same point.

One great advantage of these proof lines will appear, when we take into consideration that most of the instruments used in mines for taking horizontal angles have no vernier scale for reading off the fraction of the angle; and, therefore, if the bearing falls between any quarter, or half of a degree, the surveyor must depend on the judgment of his eye for the division, and let it be known that an error of one quarter of a degree in 100 feet amounts to 5 inches and a decimal of ·23596, or upwards of 2 feet 7 inches in a line of 100 fathoms; hence the value of having this most satisfactory and convenient check for the laying down of the last grand line must be manifest to every observer, and should never be neglected.

LOGARITHMS.

Should the practitioner wish to prove the finding of the angle and hypothenuse by logarithms, the following is the rule:—

From less side 346 and radius	=	12·5390761
Subtract longest side, 419·4	=	2·6227140
Log. tangent of 39° 30′		9·9163621

RULE FOR THE HYPOTHENUSE.

From less side and radius (as before)	12·5390761
Subtract sine of 39° 30′	9·8035105
Logarithm of 543·8 nearly	2·7355656

The rules expressed at length read thus:—

FOR THE ANGLE.

Add the radius to the logarithm of the less side, and from the sum subtract the logarithm of the greatest side; the remainder, or sum, will be the tangent of the angle opposed to the less side.

FOR THE HYPOTHENUSE.

Add the logarithm of the given side to the sine of the angle opposite to the side required, and from the sum subtract the sine of the angle opposed to the given side; the remainder will be the logarithm of the side required.

SYSTEM.

There is much propriety in the remark, that "system is the handmaid of science," and the term may be considered as used in contradistinction to disorder, irregularity, or random. The man who would excel in the important work of mine-surveying should have a *system*, and a good one. It is true, men are apt to be bigoted in this matter, and think so highly of their own system as to despise all other; but certainly we must admit that a bad or an imperfect system is better than no system at all. He who has no fixed rule is liable to error every step he takes. We would recommend the young dialler to adopt a system in keeping his register, or dialling book underground, so that his subterranean surveys may be perfectly clear and comprehensible, not only to himself, but to all practical men. Let us suppose we have to survey a level driven on the course of the lode, where there are several cross cuts driven off to the right and left. I would advise the student to keep the number of his drafts on the main line, or course of the lode, in regular numerical order; and when he has to branch off on a cross cut, let him make the necessary mark, and call the first draft in that cross cut Number 1, and so on in succession to the end of it. On his return to the mark where he departed from the main line, let the dialling on the cross cut stand in the book as a *parenthesis*, and let him *resume* his course on the lode, numbering his draft in order from where he branched off. By this system, he will have no turning from one place to another in his book—all will be regular; and if the main course, or any other, should be required to be copied separately, in the fair dialling book, it can easily be done. Moreover, should a diagram or geometrical plan of the level and all its windings, and drifts or cross drivings, be required, by this mode of entry ever thing will appear in its proper place.

Another part of the "system" is, to let the sight or vane fixed at 360° always take the lead, and the surveyor's eye placed at the opposite vane, except when taking back observations. This will be found under the head of remarks connected with the "converting table;" and in horizontal dialling, let two drafts be made from every station, which will expedite the work, as the dialler will only have to wait for the settling of the needle once, instead of twice by the other method.

SURVEYING WITHOUT THE MAGNETIC NEEDLE.

This is a valuable modern discovery in mine surveying, and as "necessity is the mother of invention," the general introduction of railways and tramroads in mines drove the surveyor to seek some substitute for the needle, which the attraction of iron rendered useless, and he has happily succeeded.

This method of surveying cannot be performed with the common dial; but the best circumferentors are now made with an external graduation and vernier scale, on the theodolite principle, on purpose for the performance of this work.

The method of surveying, on this principle, differs from the magnetic method chiefly in one particular, namely, that in every fresh draft the position of the bearing must be ascertained by the back observation, in the direction of the sights, and the angle made at the old station must be obtained and preserved at the new station; and this is evident, because we have no magnet for our guide. For example:—Suppose we are surveying over a railway in a level, and the last observation was 259°; after measuring the length, the instrument is removed and carried forward to the place of the light where the angle was taken, and a mark and light left at the old station. Then, after the instrument has been adjusted in his true place, the next act of the surveyor is to place the centre of the vernier on 259°, as it stood at the old station; and if the instrument does not move by rack-work, he must keep all firm with his hands, and turn the head toward the last station, until the candle is seen through the sights. He then removes behind the instrument, and moves the sights in the direction for the next draft, where the assistant is holding a light for the purpose (the graduation being fixed), and this new draft gives (say) 270¼°, showing a difference between the two drafts of 11¼°. Although this process is somewhat tedious in description, it is simple in practice, and the history of one draft is as well as a hundred; and we may observe, that with proper care and judgment, this is the most perfect method of surveying, because there is no risk of attraction; and as the circle is much larger than the inside plate, and the divisions more distinct, together with the vernier scale being applied, the angle can be read off to one or two minutes, a nicety which cannot be attained by the needle in the common way. It is hardly necessary to state, that, in order to obtain the bearing, there must be at least one draft in the traverse where the needle must be brought into play, and this draft will determine the polarity or direction of the whole.

Further, let it be remarked, that a survey may be resolved into bearings, and worked trigonometrically, when this method is used, as by the needle.

Suppose a case that we are about to survey over a railway, but there is space enough clear of iron for the first draft; and taking the observation with the needle, we find the north point (a right-hand dial) stand at 176½°; we then fix the outer circle

with the vernier precisely at the same point, and then, throwing off the needle, perform all the remainder of the traverse by means of the outer circle. Hence it will be evident, then, if the outward circle is also graduated toward the right hand, that the whole course will come under the immediate operation of the "converting table," as if the work had been performed with the needle; and if the graduation should be reversed, the "left-hand" bearings will apply accordingly, regard being had to inversion in both cases.

This instrument is also well adapted for taking the bearing of diagonal or underlaying shafts, having a lift of iron pumps; a job that has often baffled the skill and ingenuity of diallers, and occasioned numerous and most serious errors.

The operation may be performed thus:—Suppose we are in the 60 fathom level, and from thence to the 100, the shaft was sunk on the course of the lode, on an underlay of 3 feet per fathom northerly. By applying the instrument at some point in the level near the shaft (but far enough away to be free from attraction by the pumps), we find the bearing by the needle, to a point opposite the shaft, to be due west, and the vernier on the outer rim standing at 90°; we then remove the instrument to the shaft, where the light was held, and adjust the back observations as before directed, having 90° on the outer rim, and the needle thrown off as useless, because we are now close to the pumps. A light is to be carried down the shaft as far as it can be seen, and after the graduated circle has been screwed fast, the rack is applied, and the sights turned until we cut the candle in the bottom of the shaft. This being done, we examine and read off the degree against the point of the vernier, which proves to be (say) 187¾°. Now, as when the instrument stood in a due west position the outer circle stood at 90°, and in taking the bearing, it stood at 187¾°, therefore, by subtracting 90° from 187¾°, we find the gain to the right hand of west is 97¾°, and, the underlay being northerly, the true bearing of the shaft is 7¾° east of north.

The imperative call for accuracy in cases of this kind, will be seen when it is considered that the diagonal part of this shaft is upwards of 40 fathoms, and the underlay 3 feet in a fathom, consequently, the whole base is more than 20 fathoms; and an error in the bearing has the same effect on the survey as if it had been made in taking a horizontal draft of 20 fathoms long, and on which an error of 4° would throw the end of the line nearly 9 feet too far either to the right or left.

Should a dialler be called to do a job of this kind in the absence of a suitable instrument, he may accomplish it in the following manner:—Let him fix a cross-staff in such a position that, through one pair of sights, he can see the candle in the shaft, and in the line of the other pair, he has the dial fixed in the level, out of the way of the attraction; consequently, the light in the shaft,

and the dial in the level, are two objects forming a right angle with his cross-staff. He then requests his assistant to look at a light held immediately over the head of his cross-staff, through the sights of the dial, and he finds this (say) 12° north of west; and as the bearing of the shaft is exactly at right angles with this line, if the underlay is northerly, the bearing of the shaft will be 12° east of north, if southerly, 12° west of south. The best cross-staffs, or instruments, for the express purpose of taking right angles, are now made of a hollow cylindrical shape, of brass, with cuts or apertures for taking the observation; but a substitute may be used on a pinch, by drawing two lines at right angles on a board, about 6 inches square and an inch thick; let these lines be cut half an inch deep with a fine saw, and then fix it on a three-feet stand; if the lines are truly drawn and cut, this rough instrument will serve until a better one can be procured.

CONSTRUCTION.

The old method in laying down a traverse was by drawing a parallel line, and removing the protractor at every draft. The evils of this practice are too glaring to require remark.

Fix your protractor, and lay off as many drafts as will come within the convenient range of your parallel ruler; number them in order as they stand in your dialling book; remove the protractor, and lay off the first draft from the centre direct; then apply the protractor to the centre, and No. 2, and make the parallel movement until you touch the end of the last line, or No. 1, and then draw and point off the length of No. 2, and so on through all the drafts you have pointed off from the protractor.

The advantages of laying down or pointing off a number of drafts at one fixing of the protractor, and then applying them in their true length and position, is most conspicuous; and the geometrician will testify of its superiority, both as it regards accuracy and expedition.

CONVERTING TABLE.—REMARKS ON THE FOLLOWING TABLE FOR CONVERTING THE DEGREES RECORDED IN THE DIALLING BOOK OF AN UNDERGROUND SURVEY INTO THE BEARINGS.

All practical men are aware of the difficulty, hazard and delay, that attends an attempt to obtain the bearing of every draft underground, in a long and complicated survey. The best process is to record the degree, or angle only, at which the needle settles, and after the work is finished underground; then convert the various angles into the real bearing or true direction of each draft, and we may remark, that the bearings *must* be obtained if the work is to be mathematically proved. But as it is not an easy matter to turn a long course of dialling into the bearings, with an assurance of being correct, this table has been constructed

for that express purpose; and its utility, simplicity, and perfection has been acknowledged by many practical men.

EXPLANATION.

All circumferentors (dial or miner's compass) are not graduated alike. In all cases, 360° stands at the north point, and 180° at the south; but some are figured toward the right hand, from the north point (which we call a "right-hand dial"), and others toward the left-hand, so that a "right-hand dial" has 90° at the east point, and a "left-hand dial" has 90° at the west point. This diversity of graduation has often caused much perplexity and confusion among diallers. The following table is contrived to suit both sorts of instruments; and is so plainly arranged and marked, as to require but little explanation. It must be specially regarded, that the table has been constructed upon the considera-ion that the eye of the surveyor has been applied to the south sight or vane standing against 180°; this must be invariably the case. Hence the north sight must always take the lead, and the young practitioner may here be told that in dialling a level and making double, or fore and back drafts, at every station, that although his eye must be placed at the *north* sight, necessarily, for the back observation, yet as the dial has not been turned, the needle will stand to the true degree for the record, and no confusion or liability to error can occur.

In converting an underground survey, or any other, from angles into bearings, it is obviously our first object to know the graduation of the instrument by which the work has been performed; and if it has been a "right-hand dial," and the first draft was on 167°, the bearing would be 13° west of south, but if it was done by a "left-hand dial" the bearing would be 13° east of south. The only thing where a liability to error at all exists in obtaining the bearings by inspection from this table, and where caution is required, is in applying the fractions of degrees when they occur in the drafts. On these occasions, observe that when the angle and bearing progress alike, as in all the left-hand side of the column, then the fraction must be *added* to the whole number of the bearing; but otherwise, as in the right-hand side, the fraction must be *deducted* from the whole number. Lastly, the following desirable proof may be resorted to:—If the course has been correctly converted, the degree and bearing added together or subtracted from each other will make one of the following numbers:—0, 90, 180, 270, 360; and this may be done almost at a glance after the survey has been converted into bearings.

APPLICATION OF THE CONVERTING TABLE.

Suppose the needle stood at 246½°, what is the bearing?

Answer { By a right-hand dial 23½° South of E.
By a left-hand dial 28½° South of W.

TABLE FOR CONVERTING ANGLES INTO BEARINGS.

Rt. Hd. Dial. W. of N. Lt. Hd. Dial E. of N.		Rt. Hd. Dial N. of W. Lt. Hd. Dial N. of E		Rt. Hd. Dial S. of W. Lt. Hd. Dial S. of E.		Rt. Hd. Dial W. of S. Lt. Hd. Dial E. of S.	
Angle.	Bearing.	Angle.	Bearing.	Angle.	Bearing.	Angle.	Bearing.
1 is	1	46 is	44	91 is	1	136 is	44
2	2	47	43	92	2	137	43
3	3	48	42	93	3	138	42
4	4	49	41	94	4	139	41
5	5	50	40	95	5	140	40
6	6	51	39	96	6	141	39
7	7	52	38	97	7	142	38
8	8	53	37	98	8	143	37
9	9	54	36	99	9	144	36
10	10	55	35	100	10	145	35
11	11	56	34	101	11	146	34
12	12	57	33	102	12	147	33
13	13	58	32	103	13	148	32
14	14	59	31	104	14	149	31
15	15	60	30	105	15	150	30
16	16	61	29	106	16	151	29
17	17	62	28	107	17	152	28
18	18	63	27	108	18	153	27
19	19	64	26	109	19	154	26
20	20	65	25	110	20	155	25
21	21	66	24	111	21	156	24
22	22	67	23	112	22	157	23
23	23	68	22	113	23	158	22
24	24	69	21	114	24	159	21
25	25	70	20	115	25	160	20
26	26	71	19	116	26	161	19
27	27	72	18	117	27	162	18
28	28	73	17	118	28	163	17
29	29	74	16	119	29	164	16
30	30	75	15	120	30	165	15
31	31	76	14	121	31	166	14
32	32	77	13	122	32	167	13
33	33	78	12	123	33	168	12
34	34	79	11	124	34	169	11
35	35	82	10	125	35	170	10
36	36	81	9	126	36	171	9
37	37	81	8	127	37	172	8
38	38	84	7	128	38	173	7
39	39	85	6	129	39	174	6
40	40	80	5	130	40	175	5
41	41	86	4	131	41	176	4
42	42	87	3	132	42	177	3
43	43	88	2	133	43	178	2
44	44	89	1	134	44	179	1
45	45	90	R. H. D. W. / Lt. H. D. E.	135	45	180	South.

It may be remarked, that the table is equally applicable for changing bearings into angles if required. For example:—An observation was made with a right-hand dial, and the bearing found to be 27° 17′ E. of N., at what degree did the needle point?

Ans. 332° 43′, and if proof is required it will be seen that the sum of these degrees and minutes is 360°.

EXAMPLE.

Convert the following angles taken with a left-hand dial into bearings:—

210¼° 176¼° 205½° 28¼° 107¼° 97¾°

Operation.			Proof.
210¼° is	30¼	W. of S.	210¼ — 30¼ = 180
176¾	3¼	E. of S.	176¾ + 3¼ = 180
305¾	35¾	N. of W.	305¾ — 35¾ = 270
28¼	28¼	E. of N.	28¼ — 28¼ = 0
107¼	17¼	S. of E.	107¼ — 17¼ = 90
97½	7½	S. of E.	97½ — 7½ = 90
348	12	W. of N.	348 + 12 = 360

TABLE FOR CONVERTING ANGLES INTO BEARINGS.

Rt. Hd. Dial E. of S. Lt. Hd. Dial W. of S.		Rt. Hd. Dial S. of E. Lt. Hd. Dial S. of W.		Rt. Hd. Dial N. of E. Lt. Hd. Dial N. of W.		Rt. Hd. Dial E. of N. Lt. Hd. Dial W. of N.	
Angle.	Bearing.	Angle.	Bearing.	Angle.	Bearing.	Angle.	Bearing.
181 is	1	226 is	44	271 is	1	316 is	44
182	2	227	43	272	2	317	43
183	3	228	42	273	3	318	42
184	4	229	41	274	4	319	41
185	5	230	40	275	5	320	40
186	6	231	39	276	6	321	39
187	7	232	38	277	7	322	38
188	8	233	37	278	8	323	37
189	9	234	36	279	9	324	36
190	10	235	35	280	10	325	35
191	11	236	34	281	11	326	34
192	12	237	33	282	12	327	33
193	13	238	32	283	13	328	32
194	14	239	31	284	14	329	31
195	15	240	30	285	15	330	30
196	16	241	29	286	16	331	29
197	17	242	28	287	17	332	28
198	18	243	27	288	18	333	27
199	19	244	26	289	19	334	26
200	20	245	25	290	20	335	25
201	21	246	24	291	21	336	24
202	22	247	23	292	22	337	23
203	23	248	22	293	23	338	22
204	24	249	21	294	24	339	21
205	25	250	20	295	25	340	20
206	26	251	19	296	26	341	19
207	27	252	18	297	27	342	18
208	28	253	17	298	28	343	17
209	29	254	16	299	29	344	16
210	30	255	15	300	30	345	15
211	31	256	14	301	31	346	14
212	32	257	13	302	32	347	13
213	33	258	12	303	33	348	12
214	34	259	11	304	34	349	11
215	35	260	10	305	35	350	10
216	36	261	9	306	36	351	9
217	37	262	8	307	37	352	8
218	38	263	7	308	38	353	7
219	39	264	6	309	39	354	6
220	40	265	5	310	40	355	5
221	41	266	4	311	41	356	4
222	42	267	3	312	42	357	3
223	43	268	2	313	43	358	2
224	44	269	1	314	44	359	1
225	45	270	R. H. D. E. L. H. D. W.	315	45	360	North.

EXAMPLE.

Convert the following angles taken with a right-hand dial into bearings:—

9° 45′ 239° 25′ 331° 12′ 160° 58′ 45° 6′

Operation.	Proof.
9° 45′ is 9° 45′ W. of N.	9° 45′ − 9° 45′ = 0
239 25 30 35 S. of E.	239 25 + 30 35 = 270
331 12 28 48 E. of N.	331 12 + 28 48 = 260
160 58 19 2 W. of S.	160 58 + 19 2 = 180
45 6 44 54 W. of N.	44 54 + 45 6 = 90

N.B.—In practice it would not be necessary or convenient to *state* proofs—it is introduced here for the learner's sake, that he may be enabled to insure certainty in this essential matter.

In pressing on our young mining friends the advantage of adopting a perfect system, we advise that, in preparing a course of dialling for trigonometrical solution, by changing the angles into bearings, care should be taken that all the drafts should be made either to exceed 45°, or that they should all stand below, or at least not exceed that half quadrant. Our reason for being urgent on this matter is, that there may be a uniformity in placing the sides in the traverse table after the draft has been computed. And let it be particularly noticed that, if the bearings are not suffered to exceed 45°, that the *last* expression of the bearing will signify the *longest* of the two sides. That is, suppose a draft taken underground was 287½°, measuring 45 feet 8 inches; now looking at the "converting table" we see that if this draft was taken with a "left-hand dial," that the bearing is 17½° north of west (or N. of W.) and the two sides will be found by computation to be 13 feet 7 inches, and 43 feet 7 inches. Query, into what columns respectively must these numbers be placed? As the bearing was north of west, and our system states that "the last expression of the bearing will signify the longest of the two sides," consequently the longest side (43 feet 7 inches) must be placed in the "*west*" column, and 13 feet 7 inches in the north column.

If this order is followed up, it will render the working of traverses (which is the most important operation in mine surveying) a plain, pleasing, and satisfactory exercise. In this edition we would needs bring forward every thing likely to promote the advancement of the young mining officer in this paramount branch of his profession, and therefore give him to understand that, in traversing, there must be a regular course from beginning to end.

We shall make ourselves understood in this matter, by taking a case where a person makes a survey for the purpose of ascertaining the length and bearing of a level driven on an east and west lode; and, for some convenient purpose, he begins his dialling at some point about the middle of the level, and dials from thence to the eastern end; he then returns to the station or start at the middle of the level, and dials on to the western end, and thus completes the survey.

Now if he was to proceed to work the traverse from his dialling book in this state, his results would appear as if his level was almost without length or bearing, as his eastings would be balanced by his westings, &c.

In order to go *systematically* to work in this case, his first operation must be to *reverse* the order of one or the other of the diallings; that is, if he pleases to let the first remain, which is the eastern dialling, and would accommodate the western part to suit the other, he must alter or reverse all the drafts, by converting (say) 16° south of west into 16° north of east, and so of all the rest.

In winding up this course of instruction, we will take a short survey, and go through with it at length, and the student may accompany us if he pleases; for we are still of the opinion that practical teaching is the best.

EXAMPLE.

It is required to sink a vertical shaft on the end of a level, and the diallings from the bottom of an old downright shaft are as follows:—

Surveyed with a "right-hand" dial.

			fath.	ft.	in.
No. 1.	356¼°	Length	18	3	0
2.	84¼		12	1	6
3.	98		15	4	0

		fath.	ft.
4.	A Winze 322° Underlay 25¼°, Inclined length	11	2
5.	107¾° Length 25 5 6 End.		

This is the underground work, and our first operation is to find out the underlay of the winze, in order that it may stand as a common draft in the survey.

OPERATION.

The underlay, or angle made by the dip of the winze and a vertical line, being 25¼ degrees, we find it standing in the first table against 2 feet 7 inches, showing that every fathom of the winze gives a base of 2 feet 7 inches, and the length of the winze being 11 fathom 2 feet, we multiply

```
4)  2  7
      11·2
 ---------
 4  4  5
      10
 ---------
 4  5  3
 ---------
```

Here we find the base of the winze to be 4 fath. 5 ft. 8 in.

The next thing is to refer to the converting table to reduce the drafts into bearings; taking special notice that the work was done with a right-hand dial.

We therefore find that No.	1.	356¼°	is 3¾	E. of N.
	2.	84¼	5¾	N. of E.
	3.	98	8	S. of W.
Winze	4.	322	28	E. of N.
	5.	107¾	17¾	S. of E.

Our work is now prepared for entry in the traverse table as data for trigonometrical computation.

No.	Angles and Lines.		Trigonometrical Results.			
Draft.	Bearings.	Lengths.	East.	West.	North.	South.
		fath. ft. in.				
1	3¾° E. of N.	18 3 0				
2	5½ N. of E.	12 1 6				
3	8 S. of W.	15 4 0				
4	28 E. of N.	4 5 3				
5	17¾ S. of E.	25 5 6				

The above is the table with the bearings and lengths of the drafts entered in order for receiving the trigonometrical results in their proper and respective columns, and that every thing may be clear to the learner we shall let this table remain as it is, and make a similar one, in which the computations are entered, and proceed to take out the tabular numbers from the first mathematical table, and multiply them by their respective lengths.

FIRST DRAFT.

	ft. in.		ft. in.	
∠3¾° Tabular	0 4.7	Tabular	5 11·85	
	6		6	
	2 2.2		35 11·10	
	3		3	
	6 6·6		107 9·30	
	3		2 11·92	
	6 8·9 Easting.		110 9·2 Northing.	

Now the sides of the triangle formed by the first draft are ready to be transferred to the east and north columns of the traverse table.

SECOND DRAFT.

	ft. in.		ft. in.
∠5½° Tabular	0 6·9	Tabular	5 11·67
	12¼		12¼
	6 10·8		71 7·92
	1·7		1 11·42
	7 0·5 Northing.		73 7·3 Easting.

When the bearing does not diverge much from the cardinal point, there is but little difference between the length of the hypothenuse and the longest of the legs, as in the right-hand sides of the above two drafts.

THIRD DRAFT.

```
           ft. in.                    ft. in.
∠8° Tabular 0 10·02         Tabular  5  11·3
                 8                        8
           --------                 --------
            6  8·16                  47   6·4
                 2                        2
           --------                 --------
           13  4·32                  95   0·8
               3·31                   1  11·8
           --------                 --------
           13  1·0 Southing.         93   1·0 Westing.
```

The length of the draft being 15 fathom 4 feet, we have multiplied by 16, and deducted ⅛ as the shortest method.

FOURTH DRAFT, OR BASE OF WINZE.

```
           ft. in.     in.              ft. in.     in.
∠28° Tabular 2  9·8 or 31·8    Tabular  5  3·6 or 63·6
                        5                          5
                    -----                      -----
                    169·0                      318·0
                      4·2                        7·9
                    -----                      -----
                12) 164·8                  12) 310·1
                    -----                      -----
                   13 8·8 Easting.         25·10·1 Northing.
```

In the above, it will be seen that we have thrown the tabular length into *inches* and parts, and the practitioner will find this, in general, the easiest way of calculating.

FIFTH DRAFT.

```
            ft.  in.     in.               ft. in.    in.
∠17½° Tabular 1  10·0 or 22·0    Tabular 5  8·6 or 68·6
                          26                        26
                       -----                    ------
                         132                     411·6
                         44                     1372
                       -----                    ------
                       572·0                    1783·6
                         1·8                       5·7
                       -----                    ------
                   12) 570·2                12) 1777·9
                       -----                    ------
                      47·6·2 Southing.          148·1·9 Easting.
```

Now the computations are ready for entry in the following table:

No.	Angles and Lines.		Trigonometrical Results.			
Draft.	Bearings.	Lengths.	East.	West.	North.	South.
		fath. ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
1	34¼° E. of N.	18 3 0	6 8·9	. .	110 9·2	
2	5¼ N. of E.	12 1 6	73 7·3	. .	7 0·5	
3	8 S. of W.	15 4 0	. .	93 1·0	. .	13 1·0
4	28 E. of N.	4 5 3	13 8·8	. .	25 10·1	
5	17½ S. of E.	25 5 6	148 1·9	. .	. .	47 6·2
			242 2·9	93 1·0	143 7·8	60 7·2
			93 1·0		60 7·2	
			149 1·9	Easting.	83 0·6	Northing.

Now we might proceed to lay down the position or place of our new vertical shaft at the surface without any further operation. For by measuring off from the centre of the old shaft at surface 149 feet 2 inches, due east, and from the end of that line measuring 83 feet due north, would bring us exactly over the end of the fifth or last draft, where the shaft is to come down, but we would work out the direct length and bearing also, as before described, and apply it.

PROBLEM.

A new vertical shaft was commenced which is intended to intersect the main lode at the depth of 100 fathoms below the adit level, which is about 40 fathoms from surface in the vicinity of the new shaft. From a point in this level, a drift or cross-cut has been begun, and designed to be driven in a direct line to the centre of the new shaft, and from thence to rise against it, if necessary; and the aim and object of the survey is to ascertain the exact length and bearing of the said cross-cut, as every proper means have been adopted to certify that it has been commenced at the nearest point of the shaft.

The following is the whole course of dialling in its most simplified form, with the irregular surface lines reduced to horizontal measure, the angle of every draft converted into bearing, and the whole given in complete order for working the traverse without any preliminary preparation. The draft standing on the top of 934 feet is from the centre of the new shaft at surface to a line hung in the old engine shaft, which is also vertical to the adit, and the next draft is taken from that line in the adit and continued to the end of the 34th draft, through the same level, where the cross-cut commences.

It is also required to furnish the *bearing* of the lode from the 3d to the 34th draft inclusive.

REMARKS.

As this course of dialling has been rendered so plain, there appears to be no occasion to introduce a double entry of it, as the field and underground work is sufficiently manifest in the first three columns of the following table, in combination with the trigonometrical operation. It may be satisfactory to the student to be informed that this work has been accomplished and proved to be perfectly correct. The cross-cut was driven all the way (50 fathoms) through a hard granite country, at nearly £1,000 cost, and occupied full two years of uninterrupted labor.

Then by the following method of proceeding, the required answers will be found as follows:—

Length of cross-cut from adit to centre of shaft, 300 feet 2 inches.

Bearing of cross-cut 1° 2′ west of north.

Bearing of lode from 3d to 34th draft, inclusive, 2⅛° south of east.

COMPUTATION.

No.	Angles and Lines.			Trigonometrical Results.							
Drafts	Bearings.	Lengths.		East.		West.		North.		South.	
	From new Shaft to Engine Shaft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
1	14° 18′ S. of W.	934	0	.	.	905	0·7	.	.	230	8·3
2	13¾ S. of E.	30	0	29	0·7	.	.	.	.	7	1·6
	4½ E. of S.	30	6	2	6·3	.	.	.	.	30	4·3
	On course of lode										
3	5¼ S. of E.	28	6	28	4·5	.	.	.	.	2	8·8
4	4 N. of E.	42	6	42	4·7	.	.	2	11·6		
5	16 S. of E.	30	8	29	5·8	.	.	.	.	8	5·4
6	2¼ do.	32	0	31	11·7	.	.	.	.	1	4·7
7	18½ do.	29	2	27	8·9	.	.	.	.	9	1·6
8	4½ do.	18	0	17	11·5	.	.	.	.	1	4·0
9	3½ N. of E.	36	0	35	10·2	.	.	2	2·4		
10	13 S. of E.	17	0	16	6 8	.	.	.	2.	3	9·9
11	19¾ do.	26	6	24	11·2	.	.	.	.	8	11·4
12	14 do.	22	7	21	11·0	.	.	.	.	5	5·6
13	15 do.	36	3	35	0·1	.	.	.	.	9	4·6
14	1 do.	46	6	46	5·9	.	.	.	.	0	9·8
15	17 N. of E.	41	3	39	5·4	.	.	2	0·7		
16	4 do.	11	2	11	1·7	.	.	0	9·3		
17	21½ do.	12	8	11	9·4	.	.	4	7·7		
18	1 do.	27	0	27	0·0	.	.	0	5·7		
19	2 do.	38	8	38	7·7	.	.	1	4·2		
20	1 S. of E.	18	0	18	0·0	.	.	.	.	0	3·8
21	20 do.	12	6	11	8·9	.	.	.	.	4	3·4
22	7 do.	11	6	11	5·0	.	.	.	.	1	4·8
23	1 do.	25	8	25	8·0	.	.	.	.	0	5·3
24	4 N. of E.	31	6	31	5·1	.	.	2	2·3		
25	13 S. of E.	34	6	33	[illegible]·4	.	.	.	.	7	9·1
26	1 N. of E.	18	8	18	8·0	.	.	0	3·9		
27	5 do.	28	0	27	10·7	.	.	2	5·3		
28	8 S. of E.	65	0	64	4·4	.	.	.	.	9	0·6
29	2 do.	36	6	36	0·4	.	.	.	.	1	8 3.
30	5 do.	18	0	17	11·2	.	.	.	.	1	6·8
31	6¼ N. of E.	24	8	24	6·0	.	.	2	9 5		
32	1 do.	12	3	12	3·0	.	.	0	2·6		
33	18 do.	29	6	28	0·7	.	.	9	1·4		
34	12 do.	20	1	19	7·8	.	.	4	2·1		
				899	6·1	905	0·7	45	8·7	345	9·6
						899	6·1			45	8 7
				Westing		5	4·6	Southing		300	1·9

PROBLEM.

A lode was opened on the back by costeening in several places, and its course, by compass, found to be 10½° south of east; but this was on the ascent of a steep hill whose angle of elevation was 16½°, and the lode underlying northerly three feet in a perpendicular fathom.

Query. What is the true bearing or course of the lode? and what would be the amount of error in carrying on the line 600 fathoms (horizontal measure) supposing the run of the back of the lode on the ascent had been taken, by mistake, instead of the true horizontal course?

OPERATION.

We find in the first table that 16½° of elevation gives 1 ft.

8·45 in. perpendicular, and 5 ft. 9·04 in. base for the corresponding sides of the triangle.

```
                ft.          ft.                       ft.  in.
Hence If 6 perp. gives 3 underlay, what will 1  8·45 give?
        12          12                         12
        --          --                        -----
        72          36                        20·45
                                                 36
                                              -----
                                        72) 736·20 (10·2
```

Showing that the underlay of the lode carries the line 10 1-5 inches further north than the line taken at the surface (or bearing) on every horizontal line of 5 ft. 9·04 in. Therefore we have the two sides of a right-angled triangle 5 ft. 9·04 in. and 10·2 in., and the angle opposite the shortest side will be the amount of the angle of error.

```
 ft.  in.     in.     feet.
As 5  9·04 : 10·2 : :  6
   12                 12
 -----               ----
 69·04                72
                      10·2 in.
                     -----
             69·04) 734·4 (10·63
```

By inspection of the 2d table we find the nearest next less angle standing opposite this number (10·63 in.) is 8° 15′, giving 10·44 in.; and as the difference between this and the next greater (8½) is ·32, and the difference between 10·63 in. and 10·44 in. is ·19, we say,

As ·32 is to ·19, so is 15′ = 9′.

And 9′ added to 8° 15′ gives 8° 24′ for the angle of error; and by deducting this angle of error (if it may be so called) from the course of the lode on the inclined surface (10½ south of east), we have 2° 6′ south of east for the true bearing of the lode; and as the error is 10·64 in. in a horizontal fathom, this number multiplied by 600, gives 6384·00 inches, or 88⅔ fathoms, too far south, on a line of 600 fathoms.

REMARKS.

We beg to call the particular attention of our mine agents to this case. The vast sums of money expended every year in this country, in costeening for right-angle open cuttings at the surface in searching for lodes, is well known to practical men; and probably there is no branch of mining in which there is a greater waste of time and money. Workmen are often put to costeen at random, when a scientific survey might have put them in a position for opening the lode in a few hours which has occupied them for weeks or months, and at the last all their labors fraught with doubt and uncertainty; but these are not the worst consequences arising from ignorance or inattention to this subject. I know a rich mine in this county, where the angle of ascent was made in error, and carried on to find the lode in the adjoining

set, and the effect was, that they pitched to cut the lode in the new set nearly 200 fathoms out of the line; and they have been driving now nearly five years through a hard country at a cost of some thousands of pounds, and have not yet cut the lode! Volumes might be written on the errors that have taken place from this source; and probably there is not a man of experience to be found but what can confirm the report with his testimony.

PROBLEM.

In a 20 fathom level driving on an east and west lode, underlaying north, a winze has been commenced bearing due north, and it is determined to pitch a rise against it in the 40 fathom level (the 30 fathom level not having been driven far enough east to rise from). The following is a statement of the dialling from the middle of the above winze, in the twenty, through the level west towards another winze sunk to the 30 fathom level.

No.	deg.	ft.	in.	No.	deg.	ft.	in.
1	282¼	59	10	3	264¼	83	4
2	286	61	8	4	260¼	77	3

This brings us to the brace of the winze communicating with the 30 fathom level, which we may call No. 5, its diagonal length 65 feet, underlay, 22½ degrees; bearing, 9½° east of north. From the foot of this winze in the 30, the dialling is continued westerly to another winze communicating with the 40 fathom level; viz.

No.	deg.	ft.	in.
6	272¼	60	9
7	256¼	52	0
8	287¼	45	8

We now arrive at the brace of the winze to the 40 which we call No. 9,—length, 70 ft. 6 in.; underlay, 31½°; bearing, 4° west of north. From the bottom of this winze in the 40, the course turns easterly, and is continued in that direction; viz.

No.	deg.	ft.	in.	No.	deg.	ft.	in.
10	83	85	4	13	90	77	6
11	77	28	5	14	92¼	28	8
12	104¼	76	0	15	99	107	2

At the end of this 15th draft we place an assumed mark in the back of the 40 fathom level.

Question. It is requested to know how far we must measure east or west from this mark in order to arrive at the exact point for rising against the winze sinking from the 20 fathom level? also what will be the average underlay at that place, and what will be the length of the winze from the 20 to the 40 fathom level?

Art III.—THE MOUNTAIN FORMATION OF NORTH AMERICA.—THE GREAT TABLE LANDS.—GEOGRAPHICAL FEATURES. By W. Gilpin.

The mountain formation of North America, is that distinct subdivision of its area which occupies the whole space from the Great Plains to the Pacific Sea and covers two sevenths of the continent. In its area, bulk, number and variety of the mountain masses, it equals the aggregated mountains of all the other continents. It has peculiar characteristics which render it more interesting than them all. Travelling transversely across from east to west along the thirty-ninth degree, the breadth is *sixteen* hundred miles; the length continuous from Tehuantepec to the Arctic Sea, is *four thousand five hundred* miles; the direction is regular from south-south-east to north-north-west. From east to west the traveller enters and crosses five physical divisions, as distinct in order and succession as are the prismatic streaks of the rainbow to the eye. These are: 1st, The Black Hills, or Eastern Piedmont; 2d, The Cordillera of the Sierra Madre (Rocky Mountain); 3d, The Plateau of the Table Lands, with its mountain chains; 4th, The Cordillera of the Snowy Andes (the Sierra Nevada); 5th, The maritime Piedmont, of the Pacific shore. These divisions are parallel to one another like the streaks of the rainbow, and, like them, run throughout from end to end of the *mountain formation*, in which they are blended together in one embodied mass.

Beyond the central line of the *Great Plains*, the undulations of the surface begin to swell up, until they become elevated into secondary mountains, with timber, and crowned with rocky escarpments. These are the Black Hills. They are the outlyers of the Sierra Madre, are in the basin of the Mississippi, and masking the mountain crest, break and graduate its descent. They are three hundred miles in breadth, are perforated across by all the great rivers, and are washed away and tortured into fragments by their channels. They have rocks of porphyritic granite and sandstone, but are for the most part formed of the sulphate of lime, as gypsum or plaster of Paris. Some of them are paved with petrifactions, and others, being composed of light mould, form the suspended matter of the rivers which goes down to make the alluvial bottoms and delta of the Mississippi Basin. They have but little snow or rain, a scattered growth of dwarfed timber, and a picturesque and fantastic scenery. They are an important part of the pastoral region, are clothed in perennial grass, and abound in aboriginal cattle. Perpetual sunshine, fertility, perfect health, pure and abundant water, ever-varying scenery, and infinite animal life, will, in time, attract and fix here the densest population.

Over the Black Hills rises the Cordillera of the Sierra Madre.

This supreme Cordillera may be defined as the backbone of the world; it is the "divostia aquarum" of the American continent. From the snows of its immense crest and flanks descend the rivers that irrigate either face of the continent out to all the oceans. From it also branch off all the other mountain chains. Where the irrigation from the snows is sufficient, immense forests exist; elsewhere the mountains are naked. The core or basis of the Sierra Madre is red porphyritic granite, from the immense naked masses of which comes the popular sobriquet of "Rocky Mountains." This is the gold-producing quartz. The Sierra Madre has precipitous mural flanks which protrude outward as promontories, or recede to encase the courses of rivers and valleys. It has peaks, conical in shape, and culminating by a sharp apex. To those who view it in the horizon from below, this is its general appearance; but to those who ascend its ragged front and surmount its highest crest, this is found to be a *Mesa* or indefinite table land as level as a water surface. This Sierra Madre has its own characteristics, which are all of the grandest order. I am unable to illustrate it by comparison, because it stands supreme and alone, the standard to which all other mountain masses must be submitted. It is of the original mass of the globe, and has neither lava nor craters, nor active volcanoes, nor traces of the igneous force within. It is *par excellence* primeval. Scooped out of its main mass are valleys of great size and beauty, which have received from the trappers the name of *Parks*. These occur at regular intervals, alternately upon either flank, and mark the sources of the great rivers. Those which I have seen are the plain of the South Pass, surrounding the sources of the Ric Verde; the North Park upon the northern Platte or Nebraska River; the Middle Park upon the Rio Grande of the west; the South Park upon the Southern Platte; the Plain of St. Louis upon the Rio del Norte. These remarkable valleys are all secluded within the main dorsal mass of the Cordillera, and are of great size, fertility and beauty. They resemble those reservoirs of the Alpine torrents of Switzerland, Geneva and Constance, out of which issue the rivers Rhone and Rhine, and the Valley of Cashmere, through which the Indus flows, though they contain no lakes. They are the paradise of the aboriginal herds, with which they swarm at all seasons, and are the favorite retreats of the Indians. To define the exact width of the primary Cordillera, and mark the line where it fades into the Black Hills upon the east, and into the plateau of the Table Lands upon the west, is not easy; but it varies from one hundred to two hundred and fifty miles, according as it expands into salient promontories, or recedes to give passage to the rivers.

We next descend on to the third division, which is the plateau of the Table Lands. This expands onward to the Cordillera of the Snowy Andes. I speak again with great diffidence, but of

all the departments into which science has arranged the physical geography of the Globe, this appears to me the most interesting, the most crowded with various and attractive features, and the most certainly destined eventually to contain the most enlightened and powerful empire of the world. At present it is no more known or comprehended *as it is* by the American people than was America itself to the poet Homer, and is to them as much a myth as the continent of Atalanta. Nevertheless it is of such great area as to contain within itself three rivers which rank with the Ganges and Danube in size, and five great ranges of primary mountains. You will see it exactly defined upon the Hydrographic map of 1845, as the immense longitudinal region encased within the Cordilleras, and extending from Tehuantepec to the Northern Sea. It would exhaust a large volume to recite in detail the interesting features of this region, all worthy to be known.

The plateau of the Table Lands is a succession of *intra-montane* basins, seven in number, and ranging successively from south to north. The solid mass of the Andes debouches out of the Isthmus of Tehuantepec, and forks immediately into the two Cordilleras. Advancing along the Western Cordillera into the State of Jalisco, a mountain chain issues from its inner flank, and traversing the table lands plunges into the Sierra Madre, in the State of San Luis Potosi. This cuts off to the south the "Basin of the City of Mexico," which is the *first*, the smallest and most southern of the mountain basins. Further north, the second mountain chain crosses from Durange to Coahuila, and cuts off the "Basin of the Balson di Mapimi." This is the *second* mountain basin. The Cordilleras which flank these two and fence them from the sea, have so great an altitude that the ocean vapors never surmount their crests, nor do any clouds pass outward over them. These basins, therefore, have no outward drainage, nor any rivers running to the sea. Stagnant lakes alternately receive the drainage from their surrounding mountains, and yield it to them again by evaporation. This last chain is known as the "Mountain of the Rio Florida;" the former as the "Mountain of Queretaro."

Pursuing still the Western Cordillera through the State of Sinaloa, a third mountain chain, dividing off, traverses the Table Lands due north and plunges into the Sierra Madre between the plain of St. Louis and the middle Park. This is an immense and remarkable mountain, is thirteen hundred miles in length, and divides asunder the waters of the Del Norte and Colorado. It is the famous *Sierra Mimbres.* The area thus cut off between it and the Mountain of the Rio Florida is drained by the rivers Del Norte, Pecos and Conchos, which, uniting at the base of the Sierra Madre, perforate it by a *cañon*, and escaping into the external maritime region, from the Rio Grande of Texas. This is only the water course which perforates the Sierra Madre between

Cape Horn and the Arctic Sea. It is here that a profound and distressing error pervades all the existing charts and delineations of our continental geography. These, omitting the great Sierra Madre for six or seven hundred miles of its length, and assigning its name to the Sierra Mimbres, locate the Rio del Norte and its vast basin with the system of Atlantic rivers. Yet the Sierra Mimbres abounds in pedrigals of lava, craters and volcanic phenomena, and the geological altitude, configuration and a thousand palpable characteristic features of the basin of the Del Norte locate them upon the plateau of the Table Lands. This blunder of transposition is more foolish than to construct a map of Europe and forget the Alps, or to draw for the people a pine tree growing erect in the middle of the ocean, whilst dolphins graze upon a mountain slope! The vast basin of the Del Norte is then the *third* in order of the mountain basins of the Plateau.

The Western Cordillera continues to traverse Sonora, and, passing round the Gulf of California, reappears in sight of the ocean in the State of California. Opposite San Bernardo, another mountain chain branches from its eastern flank, traverses the Table Lands by a northern course, dividing the waters of the Colorado and Great Salt Lake, and plunges into the Sierra Madre between the sources of Green River and Snake River. This is the *fourth* great mountain chain of the Table Lands, is one thousand miles in length, and is the Sierra Wasatch. Between it and the Sierra Mimbres is included the immense Mountain basin of the Colorado, which is the *fourth* subdivision of the area of the Table Lands. This basin has an immense area, great altitude, an infinite perplexity of mountains, and is redundant in striking and wonderful novelties. The Rio Verde Rio Grande of the west, the Rio San Juan, collect its upper waters, and, uniting against the inner flank of the Cordillera of the Snowy Andes, gorge it diagonally through and through, and escape into the Gulf of California. This sublime gorge is four hundred miles in length, and is known as the "Cañon of the Colorado." It is throughout a narrow mountain chasm, traversing, without interruption, the very bowels of the Andes, having perpendicular mural sides, often many thousand feet in altitude. Other important affluents of the Colorado (the Mohabe, the Little Colorado and the Gila), force their way into it by an infinite labyrinth of gorges, similarly scooped through the bowels of the mountain mass. These two remarkable basins, then—the Del Norte and Colorado—lie against the Sierra Mimbres, as a backbone. The waters of the first gorge the Sierra Madre to the Gulf of Mexico; those of the second, the Andes, to the Gulf of California; but no gorge unites them through the Sierra Mimbres, which is unperforated. These basins are both longitudinal in shape and position; they overlap one another, and thereby multiply the number and complexity of mountain barriers. Among the physical phenomena of the

globe, this "Cañon of the Colorado" is an isolated fact, unique and sublime in interest. These two basins are, *par excellence*, the metalliferous department of the world, and are *infused* throughout with *mountains* of the precious stones, and precious and base metals—of lava, obsidian and marble—of salt, coal, and with rivers of thermal and medicinal waters.

Let me hasten to other subdivisions of equal interest. Near the forty-second degree of latitude the Western Cordillera throws off the *fifth* mountain chain of the Table Lands. This has a serpentine course, mainly east and west, is twelve hundred miles long, and forms the divide between the basin of the Salt Lake and the basin of the Colombia. It joins with the Sierra Wasatch, and immediately at the point of junction, plunges with it into the Sierra Madre. The great basin, containing in one of its depressions the Salt Lake, is the counterpart, on our continent, of the Caspian of Asia. It is, like the first and second basins, encased all around with an unperforated mountain wall, and neither sends nor receives water from any sea. Nearly opposite to Puget's Sound, a sixth chain of mountains, breaking off from the eastern flank of the Western Cordillera, traverses the Table Lands by a due northern course, and sinks into the Sierra Madre, closely enveloping the sources of the Columbia River. This is called the Okennagan Mountains, and divides the waters of the Columbia from those of Fraser River.

The Basin of the Columbia is the *sixth* in order of the basins of the Table Lands. It is the most admirable of them all. A splendid circular configuration and two primary rivers. Its size, position, and configurations relatively to the Mississippi Valley and the Pacific Ocean, make it the *élite* of them all. It extends all across the Table Lands from rim to rim, as do both its great rivers, the Snake River and the Columbia, which, uniting, gorge the Andes at the Cascades, penetrating through them to the Pacific in 46° 19′. They run from east to west and connect exactly, by convenient and single passes across the Sierra Madre, with the great rivers flowing down to the Atlantic. It partakes of all the cardinal characteristics of the other basins, having, in addition, mighty forests, navigation, a larger share of arable qualities and a superior economy in its topographical surface and position.

Such are the six primary basins and mountain chains which checker and arrange themselves into the Grand Plateau of the Table Lands, as I have seen them and become familiar with them. There is a seventh, the basin of Fraser River, with which I am acquainted only from the reports of others who have reconnoitred it. It has the same general features, though smaller, longitudinal in direction, and narrow.

We may now, then, return to the third elementary division of the mountain formation of North America, namely; the plateau of the Table Lands. We may understand its variety and vastness,

yet handle it as a unit. The lowest sedimentary points, which the waters accumulate in from the lakes of Mexico, Mappini, Gusman and Salt Lake, have an average altitude of 6,000 feet above the seas. The whole plateau has then the elevation of a primary mountain. It is every where fertile, being pastoral for the most part, but arable where irrigation is adopted. Every geological formation exists on a Titanic scale, volcanoes, columnar basalt and pedrigals of crystallized lava, porphyritic granite and sandstone, and secondary basins of the sulphate and carbonate of lime. It is universally a rainless region, and nowhere is arable agriculture possible without artificial irrigation. Pastoral culture is the prominent feature, wherein it rivals the Great Plains. The air is tonic and exhilarating, the atmosphere resplendent with perpetual sunshine by day and with stars by night. The climate is intensely dry, and the temperature variant and delicious. Habitations are not essential in this salubrious and vernal clime; the aborigines dispense with them. During three years that I have passed upon the Plateau, I have rarely slept within a house or beneath any canopy but the sky, infinitely spangled with stars. Upon this Plateau has existed, within our memory, the populous and civilized empire of the Aztecs, and in South America that of the Incas. Timber grows upon the rivers and upon the irrigated mountain flanks. To arrange the arable lands for irrigation is not more costly than our system of fencing, which it supersedes. No portion of the globe can maintain a denser population.

But the *fourth* subdivision of the "Mountain Formation of North America" is the Snowy Cordillera of the Andes. Everybody is familiar from childhood with the South American Andes. This of ours is the same, unchanged in any characteristic, except an increased and superior grandeur. Let us restore to it its ancient and illustrious *name!* Let us inquire how it has come temporarily to be lost! The Andes traverse the American Continent in one unbroken and uniform mass from Cape Horn to Behring's Strait. Towards the ocean, to whose indented shore they are parallel and from which they are every where visible, they present a precipitous front and immense altitude; they every where surmount the line of perpetual snow. Upon this front, which receives the perpetual winds from the ocean and is bathed with its vapors, snows and forests accumulate as upon the Alps. But on their summit of perpetual congelation, these vapors condensed to ice are as solid, as perpetual, as the granite rocks. No vapors pass over to the *inner* region, which is naked of snow, timber or irrigation. Hence has come this distinctive Spanish sobriquet of this sublime sea wall—Cordillera *Nevada* de los Andes (the *snowy* chain of the Andes)—to define it specifically from the naked masses within! Thus, since this ancient and familiar Andes has come to be domesticated in our empire, within the States of California and Oregon, has it been thoughtlessly plundered of its name, defined only by an expletive *snowy*, and incon-

tinently ignored of its supreme, coronated rank in the mountain system of the world.

Finally, I am bewildered how to speak of the *fifth* subdivision, which is the maritime Pacific Front. This brings us out to meet the ocean, to blend together the varieties of sea and land, and where, among the assembled climates and countries of the globe, Cornucopia permanently dwells, with her ever redundant and overflowing horn of ripening beauty and plenty. This Maritime Pacific Front is the countepart of yours outside of the Alleghany and upon the Atlantic. It is the tide-water region. Yours has an area of 271,000 square miles, this of 420,000: this is not much broader from the mountains to the sea, but has a greater longitude. In every detail of climate, vegetation, soil, and physical formation, there is between these two seaboards the completest contrast. On the Pacific are blended, beneath the eye, and swept in at one sight, the sublime, castellated masses of the Andes—their bases are set in the emerald verdure of the plain rising gently above the sea level—their middle flanks are clothed with the arborescent grandeur of pine and cedar forests. Naked above and towering into the upper air, their columnar form of structure resembles an edifice designed to enclose the whole globe itself; but from this foundation, and rearing their snow-covered crests another mile into the firmament, shoot up volcanic peaks at intervals of one hundred miles, incasing the throats of the inner world of fire, and coruscated in perpetual snow, beneath coronets of volcanic smoke and flames.

The sublimest of the oceans, majestic rivers more worthy to be deified than the Ganges or Egyptian Nile—the grandest and most elevated of Earth's mountains, superlative forest evergreen, an emerald verdure and exuberant fertility, a mellow and delicious atmosphere imbrued with purple tints reflected from the ocean and the mountains, a soft, vernal temperature the year round; whatsoever can be combined of massive and rugged mountains, picturesque landscape, and a verdant face to nature shining under the richest sunlight, a climate soft and serene; whatsoever of all these, blended and enjoyed in combination, will accomplish to give grace, elevation and refinement to the social world, are here united to woo and develope the genius of our country and our people.

In all these natural favors our Western seaboard front is supremely more gifted than the classic shores of the Mediterranean and the Asian seas—for fifty centuries the favorite theme of history, poetry and song. The embellishments which old society and the accumulating contributions of a hundred successive generations add to nature, are not yet there; but these will come, and to us who fan the career of our great country whilst we live, the future which posterity will possess and enjoy is full of the radiance of true glory.

ART. IV.—ON THE PRODUCTS OF LIME—ARRAGONITE.*

ONE of the most remarkable of products of lime is Arragonite, so called from the province of Arragon in Spain, where it was first discovered. It generally occurred massive, the texture being fibrous, with a silky lustre; it is sometimes colorless, although occasionally it has a brownish or greenish tint; the hardness varies from 3½ to 4, and the specific gravity is about 3. In its chemical composition it is said to contain strontia, this, however, could only be in small quantities, and it does not occur in some of the specimens found in Hungary and Bohemia. A curious question has arisen among geologists how arragonite has been formed. By some it has been stated that when carbonate of lime has been thrown down at a high temperature, arragonite has been found deposited. This mineral had been discovered in the highly mineralized waters of Carlsbad—the waters there being in a state of ebullition, the carbonate of lime became cemented. At St. Helena arragonite fills up the interstices of the volcanic rock; there it forms a fibrous and colorless mass—and where arragonite is formed in preference to calcareous spar, a higher temperature must have taken place. Sometimes this mineral is found in caverns above the sea, as it appears at Tokat in Asia Minor, where it is found in such quantities that it could be employed as marble; in England it is not a common mineral—sometimes it is met with in Somersetshire, and at Alston Moor there is a bed of fibrous variety which is termed satin spar; some of its acicular crystals so much resemble that of carbonate of lead that they are often mistaken for each other. Specimens of each were then exhibited in order to show the similarity between them. At Bilin in Bohemia it occurred in a vein traversing basalt; the most beautiful specimens, however, occur at Eisenerz in Styria, where the branching or corraloidal varieties occur, and appear disposed in the form of stalactites on the roofs and sides of cavities —to these are given the name of flos ferri. In Arragon it was first found in large detached twin crystals disseminated in a ferruginous clay, accompanied by sulphate of lime; it scratches calcareous spar. Carbonate of lime, sometimes called calcite, occurs crystallized in upwards of 800 varieties, originating from an obtuse rhomboid of 105° 5′ and 74° 55′, this may be easily obtained by cleavage, and may occasionally be cleaved parallel to a plane; several models of crystals were then shown, together with diagrams of their faces, and described. Twin crystals are common in this substance; these are generally aggregated together according to certain laws. Calcite often occurs in groups of crystals, sometimes in crystalline marbles, at others in mountain masses, it rarely occurs like arragonite; its hardness is 3, and its specific gravity is 3. In its purest state it is colorless, often of a smoky

* A Lecture before the Government school of Mines—England.

light gray hue; it is frequently transparent, and is then strongly doubly refractive. The crystals are sometimes vitreous, at others they are opaque, and one variety is found with a rim round it. A species which had been found at Alston Moor, appears as if it had been scratched with a pen by a student to mark the crystalline forms; the coloring matter here is generally ascribed to iron-pyrites. Some very curious and interesting papers on carbonate of lime had been written by Prof. Dana, the mineralogist, which he would recommend to their perusal. Double refraction was one of the most curious characteristics of this mineral; the various modes in which this could be proved were then illustrated. There were different varieties of carbonate of lime; at Andreasberg in the Hartz, six-sided prisms have been found in great beauty. A splendid crystal, from Cornwall, was exhibited, and its properties pointed out and tested by the goniometer. A variety of this was sometimes distinguished by the appellation of schiefer, or slate spar. This occurred massive, was translucent, yielding easily to the knife, and sometimes possessing a greasy feel; another was aphrite, or earthy foam, which was found occasionally solid, more often in a friable state; this differs principally from the schiefer spar in being less coherent, and is found rather abundantly at Eisleben in Thuringia, in mountains of stratified limestone. Anthraconite, or swine-stone, which emits a fœtid odor when scraped; this is found columnar, granular, and compact, and of various shades of gray, brown, and black, some of the harder sorts receive a hard polish, and can then be employed for the purposes of ornamental architecture; oolite or roe stone is alwas massive and in beds; when mechanically mixed it is called hydraulic limestone. Portland and Bath stones are varieties of this, and as a building material its properties are generally well known. Tufa is one of the most impure and porous of all the carbonates of lime, being an alluvial deposit from calcareous springs. Great quantities of this are found near Terni in Italy as well as in some places in Germany; it has the property of incrusting other substances. Pearl spar, or dolomite, so called in honor of the geologist Dolomien, has a hardness of 3½ to 4[1], the specific gravity being 2·95. It is in general of a light color, but becomes dark when exposed to the air. This, the magnesian limestone, is infusible before the blowpipe, but becomes caustic. It is sometimes called brown spar, and under that denomination is found in large quantities with lead. Sometimes it occurs of a brownish hue, accompanying veins of lead, and is then called a dun stone; it occurs with lead and with iron, and is sometimes seen in nodules of the crystals in coal mines. Arkanite is another species, containing carbonic acid, with oxide of iron and manganese—the iron being in the proportion of 32 per cent. of iron, and 50 per cent. of lime. He would lastly allude to the variety denominated magnesite, or breunnerite, from Count Breunner. Its specific gravity was under 3, while its hardness varies from 3 to 5. Some elaborate tests of the appearance of the

several varieties before the blowpipe were then described, and the lecture terminated.

The concluding lecture treated of "Quartz." The hardness of this mineral was 7, the specific gravity being 2·6. It was found in various forms, massive, crystallized, stalactitic, pseudomorphous, granular, and compact, as well as spongiform. It is largely met with in pebbles, gravel, and sand. One of its varieties is amethyst, which differs from common quartz in color, having a violet tinge, supposed to be derived from a small quantity of iron and manganese which it contains. The color is often white with a variety of tints, and sometimes, as in the case of rock crystal, perfectly limpid and transparent. Chemically it is almost entirely composed of silica, but always with the admixture of other substances, some varieties partaking of this in a greater degree: all are sufficiently hard to scratch glass. They do not yield to the knife; will strike fire with steel if compact enough, and are infusible alone before the blowpipe, though with soda it becomes fusible. Several beautiful specimens of rock crystal had been found of considerable size; there was one at the "Jardin des Plantes," in Paris, 2 feet across; in the cabinet at Vienna there was another, 4 ft. long and 1 ft. broad. Some specimens of this variety from Dauphiné and Madagascar were then exhibited. In the Alpine regions these were generally found in drusy cavities in mica slate; some of these that had a duller tint were occasionally called smoke topazes; many of these had been found at Cairngorum, and from that locality received their designation. Quartz was found in a great variety of conditions, often containing substances of other value. Crystals had been obtained from Tintagel, having in them a mineral called rutile, which was an oxide of titanium; epidote and hornblende were found under the same circumstances. Quartz generally occurred in rocks of a primary character; in the sandstone rocks of our island the crystals of quartz were commonly met with. If often occurred in crystals at St. Gothard, Snowdon and other localities, and some good specimens had been obtained in Ireland and at Bristol, the apellation of Bristol and Irish diamonds being very general The latter denomination was often set in Irish bog oak, for bracelets and other articles of ornament; good crystals are frequently found in hollows or vughs. The granitic quartz of Cornwall were then alluded to, as well as the crystals of an amethystine color, which occur in the lead mines of Derbyshire and are worked in limestone. Some beautiful specimens were then shown of varieties from the south of Cork and Wheal Uny; the purple coloring, as he had said previously, was generally supposed to be derived from oxide of manganese—but Fuchs, an eminent chemist, says that its hue cannot be deduced from that mineral. Graphic granite was then described. Quartz found in felspar and porphyritic elvans has been found useful for building purposes, and Mr. Robert Were Fox had in some papers

discussed the position and constituents of the elvan dykes near Falmouth. Common quartz was often found associated with gneiss, mica slate, and the conglomerates. Some specimens of Californian quartz were then shown and described. Rose quartz was obtained principally from Siberia; when this was cut and polished it formed a handsome ornamental stone; milky quartz was of the same nature, only differing in color. The best varieties of this were found in Greenland. Prase, another species, was of a dark green color, from the admixture of amphibole; this occurs massive, and is found commonly in the iron mines of Breitenbrunn, in Saxony. Cat's eye is a variety of fibrous quartz, with thin filaments of amianthus, which is a species of asbestos. When the stone is cut it presents an opalescent streak of light, something similar to that of a cat's eye; it is very scarce in Europe, its principal localities being in Ceylon and on the Malabar coast. Avanturine is another species, enclosing small laminæ of mica, which, when polished, presents the appearance of being spangled with gold. The most common color of the base is a reddish brown. Some specimens were then shown from the Restormel Mine of a brilliant color, which had been colored by the red peroxide of iron; ferruginous quartz, or eisenkiesel, as it was called in Germany, presents several shades of yellow and red, and occurs both massive and crystallized, consists chiefly of silica, with about 5 per cent. of iron; it occurs in Bohemia, in the ironstone veins in the Hartz, and at Altenburg, in Saxony; it is sometimes called there red jasper. A description of the various subdivisions of jasper were then given, the porcelain variety being quite distinct from either the Egyptian or the striped and ribbon jaspers. The Lydian stone was then alluded to, and its properties fully entered into; of the opal there are several varieties; the hardness is 6½, the specific gravity is 2 or 2·2. The precious opal, which is so well known for the brilliant and changeable reflection of colors it exhibits, is easily broken, but scratches glass, is found at Cservenitza, in Hungary, accompanied by the common opal. Some of the smaller there are crushed up, because they should not become too general, and deteriorate the value. It is found in other localities, but not met with so frequently. The common opal is of various shades, but entirely devoid of the play of colors above mentioned. The fire opal is found with the noble species in Hungary, but is much scarcer. It only shows bright hyacinth and red tints when turned towards the light; its principal locality is Zampan, in Mexico. Several other sorts have been met with, varying in their characteristics, though bearing a general affinity to each other. Agates were impure varieties of calcedony. The brilliant and varied colors of these were so well known, that it was not necessary to enter into any further details regarding them. The colors of calcedony were of various shades of white, gray, yellow, brown, green, or blue, but mostly uniform. It is

harder than flint, and is infusible. It is found in several localities, the principal being Iceland and the Faroe Islands. The onyx, a variety of this, was especially valuable for the formation of cameos. Plasma is grass green, found in India and China, and is brought here in the shape of beads and other ornaments.* Heliotrope, or bloodstone, is well known, on account of its value, by lapidaries; by some it has been erroneously called hematite. Chrysoprase is of an apple green color, and much prized likewise by jewellers; its color is attributed to a small portion of nickel which it is said to contain. At Koesmütz, in Silesia, it is discovered in veins traversing serpenite, accompanied by calcedony, opal, quartz, and pimelite. A species of calcedony, when black, is denominated sardonyx. Cachalong is opaque, of a milk white color, and found in loose masses on the banks of the River Cach, in Bokhara, from whence it derives its name. Cornelian and agate do not differ much, the former is generally found in nodules of dark gray color; they are exposed to the sun for some weeks, then placed in earthen pots subjected to heat, and from this process they obtain the various hues. Hyalite is rare, and found in the cavities of trap or basaltic rocks. Siliceous sinter or Kiesel sinter occurs abundantly around, and is deposited by the geysers or hot springs of Iceland. The flint was the commonest variety of quartz; its properties were well known. Large stones of this were found in the chalk formations.

Art V.—GEOLOGICAL FORMATIONS OF CHILI.

At a recent meeting of the Academy of Sciences, Mons. A. Pissis communicated, through the medium of Mons. Elie de Beaumont, a remarkable work on orography, and on the geological formations of Chili, a country which, thanks to its Government, is, perhaps, the most settled and most promising of any of the South American States; nor would it be just not to notice that the material prosperity of a very considerable portion of the country, and the interest it has excited among Europeans, is in no small measure due to the admirable and energetic development of the mineral wealth of Chili by the directors of the Mexican and South American Smelting Company, whose large establishments at Herradura and Caldera, under the superintendence of Mr. Barnes, are being brought to a high degree of economy and efficiency.

Mons. A. Pissis says the western chain of the Andes falls gradually as it proceeds southward up to the parallel of Cobija,

where it is lost in the prolongation of the table land of Bolivia. As the chain falls, the space occupied by the endogenous rocks becomes contracted, and in a short time presents only the appearance of a few trachytic masses, isolated in the midst of stratified rocks, which are a continuation of the gypsum marls and red sandstone of Bolivia. These last, after having crossed the province of Carangas, extend nearly to the parallel of Potosi, the divisional line of the waters, and thence they proceed without interruption to the two slopes of the western Cordilleras. Crossing the desert of Atacama, the traveller sees the sandstones and marls which overlie them form a series of parallel chains from north to south, while sand and flints occupy the inferior portions of the soil. In the environs of Copiapo, the marls sink beneath the strongly-marked limestone and jaspar formation, and reappear near the sea-side with the red sandstone, which rests upon the stratified porphyry. If, instead of crossing this region in a line at right angles to the Andes, the traveller follows the head lands of this long chain to the south of Chili, he will meet with red sandstone with scarcely any interruption, and at intervals with gypsum marls and limestones, which are abundant on the eastern slope; while on the western slope are seen rocks having all the appearance of real porphyry, perfectly stratified, and forming layers sometimes only a few inches in thickness. Every thing indicates that they belong to stratified formations, and owe their present state to a metamorphic action. Independently of the chain of the Andes, these porphyry rocks form another smaller chain to the west, parallel to the first, from which it is separated by the longitudinal plain of Chili. The porphyry rocks in this district are covered with pudding stones and red sandstone, but the gypsum marls, instead of ascending to the summit of the chain, appear only towards the plain, where they form table lands, isolated, and leaning against the base of the last counterparts of the western chain. On the other side—that is to say, on advancing towards the west—the succession of strata is found interrupted by a line of syenitic rocks, on which rest the layers of porphyry, and which line forms the boundary of another geological region, where are found schistose slates, quartzites, and gneiss, that extend down to the sea side, and generally overlay the granite. If attention is now directed to the later strata, which fill the hollows between the chains, there will be seen the sands of the desert of Atacama, extending the length of the sea side up to the environs of Coquimbo, and afterwards overlying the ancient gulfs, separated from one another by small granitic chains, and which gulfs are *échelonnés* along the sea side, from Coquimbo to Valdivia. These sands rest upon a stratum of pumiceous conglomerate, which is found in several provinces of Chili, particularly near the Mexican and South American Company's Works at Herradura, in the province of Coquimbo, and at Caldera, in the pro-

vince of Atacama. The sands run gradually into combination with layers of flints that extend towards the east, following the borders of the present valleys. Underneath the pumiceous conglomerates appear in several localities calcaliferous sandstones, containing a large quantity of marine shells, which alternate with layers of lignite, that for some years past have been worked on a large scale. These marine shells are burnt, as well as recent marine shells, for making mortar, and for fluxes in smelting; and the works at Herradura and Caldera have been chiefly built with this fossil lime. The deposits of lignite, and lignitic coal, have lately been recognized in Copiapo. These sandstones, covered by the sands before mentioned, rise as they recede from the coast, and attain towards their eastern limit an altitude of from 328 feet to 492 feet. They may be followed up the present valleys to the entry of the longitudinal plain, where they are replaced by strata of clay of lacustral origin. These clays overlie strata of porphyry, sandstone, and gypsum marls. Mons. A. Pissis was induced, by the preceding observations, to subdivide the stratified terrenes of Chili into five formations:—1. Marine sands and the terrene brought from a distance.—2. The marine calcariferous sandstones, lignites, and lower clays of the longitudinal plain.—3. Limestones, and saliferous marls.—4. Red sandstones and stratified porphyries. 5. Gneiss, schistose slates, and quartzites. The uninterrupted prolongation of the red sandstone of Bolivia up to the Chilian territory, can leave no doubt as to the parallel formation of the two countries. Gypsum marls, lacustral layers, and foreign terrene following one another in the same order, and under the same circumstances of stratification, correspond evidently among themselves.

JOURNAL OF MINING LAWS AND REGULATIONS.

THE NORTH CAROLINA COAL COMPANY STOCK OPERATIONS.

Evans agt. Illius. } Superior Court—Special Term.

This was an action on a sealed note for $3,750, dated 22d June, 1853, and payable 1st January, 1855. The defence, submitted by Mr. Gerard, was that the note was given as part of the consideration for certain land which it was alleged the plaintiff falsely represented to contain bituminous or gas coal, whereas it proved to contain only anthracite coal. It was also claimed that the plaintiff falsely represented that the navigation of Deep River, on which the land was situated, in North Carolina, would be so improved by the spring of 1854 as to afford means of transporting the coal to market. The defendant and his associates, on making the purchase, organized a company to which the land was conveyed, and stock to the extent of its price was issued, in shares of $50 each, of which both plaintiff and defendant took some.

This defence was objected to by Mr. Brady on the part of the plaintiff, on the ground, that before the code, fraud of the character averred could not be received in evidence to defeat a sealed instrument, unless it showed that the contract was never duly executed. The remedy of the injured party in such a case was by a bill in equity to restrain the suit on the covenant and have it cancelled. It was insisted that the code had only so far changed the law as to admit an equitable defence when it totally avoided the contract, and the rights of all parties could be settled in the action. That in this case such rights could not be adjusted without a reconveyance of the land, nor unless all the owners and holders of stock were made parties to the record, and therefore the defendant's defence should be excluded. The Court admitted the testimony as offered, subject to exception. Conflicting proofs were then given as to the merits of the controversy, and the case submitted for decision, after argument.

COALS AND COLLIERIES.

BLACK CREEK VALLEY, PENN.

The following statements, chiefly by Mr. Algernon Roberts of Philadelphia, relate to some valuable and interesting operations in the neighborhood of Hazleton, Penn.

In coming up the beautiful valley of the Lehigh, you are carried rapidly from the wide expanse of richly clothed fields, and enter the mountain passes, which increase in boldness until near Mauch Chunk, where they become not only high but exceedingly precipitous, and so continue for more than twenty miles, as measured by the winding course of the stream. These high escarpments, through which the river Lehigh has found a channel, from the northeastern terminus of the carboniferous, are formations known as the southern and middle anthracite coal fields of Pennsylvania.

There are frequent gorges through the mountains more or less precipitous, and down which small streams of water are discharged from the dividing ridge or water shed, a few miles only to the west. The streams on the western side of this summit flow into the Susquehanna as do the waters of this, the Black Creek Valley. It might be supposed that the physical features of the country, as I have described them, presented insurmountable difficulties to the transportation of heavy products to market. They were, I admit, formidable, but not insurmountable; and those bold pioneers, the managers of the Lehigh Coal and Navigation Company, opened the way, not only by water, but they also constructed one of the first iron tracks that introduced a new era to our country. They taught us, too, that a gravity road is the cheapest of all others.

The gorges of which I have spoken, furnished us railways to the dividing waters, up one of which you have recently journeyed—that of the Beaver Meadow and Hazleton Coal Companies. The distance being short, and the summits high, the railroad gradients are necessarily steep; but when we have reached the culminating point, the difficulty vanishes, and the natural formation is well adapted to economy of transportation.

The western side of this water shed or summit falls off gently, and all the railroads yet constructed in this portion of the middle coal field, approach the highlands of the Lehigh by the most favorable gradients—that, for instance, in process of construction to carry the coal from this basin (the Black Creek valley), has, from this colliery, a continuous rising grade, for the distance of five miles, of sixteen feet per mile, to the tunnel through Council Ridge, and

thence a descending grade, the maximum of which is sixty-four feet per mile —thus the power necessary to bring the empty cars to the summit can return with the same number of cars loaded. Now this road need not stop here, but by the same light grade of sixteen feet per mile, can continue down the valley many miles farther, and, by equally favorable grades, can cross into the valley north of us, for the conveyance of the coal there deposited, and may be extended into the still more northern coal basin on the borders of Green and Buck Mountains.

You see that we have at hand the means of readily and cheaply carrying the coal to the valley of the Lehigh, and when there the modes of conveyance are as numerous and as favorable as those of the most favored. They are probably as well known to all of you as to me, and I shall not detain you by enlarging on that subject, but can more appropriately refer you to the prosperous coal operators who gather the black fruit from these fields.

The carboniferous formation is observable to the practised eye, first, by the old red sandstone, or red shale, which, in this part of the world, always underlies it—the mountain masses being thousands of feet in thickness, and form the high hills about Mauch Chunk, as well as the dividing ridges here. On this mass of rocks lie the well known strata of conglomerate, with occasional thin seams of coal, and of hard sandstone rock. These hard conglomerate and blue sandstone layers form the bed on which repose the fine coal measures, or alternating seams of true coal, black and brown clay slates, blue and gray sandstones, shales, &c.

This section of the middle coal field consists of a series of troughs or valleys, formed by parallel ridges thrown up in dividing spaces of about two miles. The tops of these dividing ridges are generally composed of either red shale or conglomerate, and the valleys of coal measures. The north-eastern end of the middle coal field is much wider than has generally been supposed, and recent developments have proven the coal basins to be considerably broader and more extensive than early geologists were willing to admit. We now know that from the Mahanoy on the south, to the Green Mountain on the north, there are six anthracite valleys, or coal basins, as they are appropriately termed; each of these basins is about one mile wide, and in length from two to ten or twelve miles, some of them being nearly continuous or identical with the southwestern extension of this coal field. The aggregate thickness of the workable coal seams is quite various, being, however, seldom less than fourteen feet, and wherever the mammoth vein or seam exists, and those consequently beneath it, 40 to 50 feet in thickness of merchantable coal must be treasured up.

Now a liberal mode of calculating the result, and which will convey to you some idea of the unbounded resources of Pennsylvania, is to estimate 1000 tons per acre of workable coal for every foot in thickness; this throws off the gain in dip or inclination, and about one-third of the gross weight for wastage and pillars. Forty feet in thickness, therefore, would yield 40,000 tons per acre, and 640 times that amount, or 25,600,000 tons per square mile.

The term canoe-shaped basins is eminently graphic and descriptive as applied to this district.

From the tops of the parallel ridges forming their boundaries, which extend in a north-eastern and south-western direction, the coal has in most cases been denuded, exposing to view, as before observed, the old red sandstones of the Devonian period, or their immediate successors, the puddingstone rocks, which have aptly been called the cradle of the coal. There are occasional instances, however, where the lowest coal seams have been spared, and these, capping the ridges, connect contiguous coal basins. An illustration of this feature may be seen a short distance east of us, where the lowest or Buck Mountain seam extends over the ridge and unites the coal strata of Little and Big Black Creek valleys.

To the geologist these varied scenes afford a rich study. What immense

upheavals and depressions must have been required to change a horizontal surface into mountain ranges and deep valleys—and then how great must have been the succeeding rush of waters that carried off the superincumbent strata of sandstone, coal and conglomerate! These mighty operations of nature are here so manifest as to leave no room for credulity. But we should thankfully bear in mind that a benignant Providence has spared for the use of man an abundance in the rich valleys of His creation.

Having attempted a general, though faint description of this interesting and important section of our State, I offer a few remarks regarding the Coal or Improvement Companies hereabouts located, and the railroad which is intended to permeate their lands.

The Union Improvement Company.—1. *Real Estate.*—It consists of fifteen hundred acres of land, all underlaid by the Buck Mountain seam of coal—thickness 14 feet; and about two-thirds of the land includes the Mammoth or Hazleton seam—thickness 26 feet; besides the two or three intermediate seams, not yet proved in this basin.

2. The timber is exceedingly heavy, and will abundantly supply the collieries, buildings, &c., for generations, and the surface soil, when cleared, will make superior agricultural land.

3. The present improvements consist of a large steam sawmill, with a shingle and lath mill attached; fifteen or sixteen dwellings, stables, &c. Also a large steam engine and boilers, intended for colliery No. 1, for the opening of which we are now making preparations.

4. *Location.*—On the completion of the Lehigh Luzerne Railroad tunnel through Council Ridge, the anthracite valley of Big Black Creek, will be as near and as readily accessible to the tide waters of the Delaware, Raritan and Hudson rivers as any other coal district, and will always be able to compete successfully, whether in productiveness, quality or cost of transportation.

Corporate Rights.—These are exceedingly liberal, the company being authorized to hold 3000 acres—to buy, sell, and convey without restriction, and to extend their capital to $1,500,000. They are free from individual liability, and have a perpetual charter.

The original owners of the estate conveyed their respective interests to the company free of incumbrance, receiving in consideration seven shares of capital stock per acre, which required the issue of 10,500 shares.

The company have authorized the sale of 2000 additional shares at $35 per share, the money to be appropriated to the opening of collieries, and preparing for active business, thus adding the whole amount to the productive capital, and avoiding any incumbrance in the shape of bonds or mortgages on the property.

About one-third of this stock has been taken chiefly by the original proprietors. When the amount of the additional stock shall have been expended in improvements, the stockholders will have a coal estate ready, we anticipate, for extensive operations, with an almost inexhaustible supply of coal, unsurpassed in all the advantages necessary to secure a profitable return for the investment made.

The Big Black Creek Improvement Co.—There is so much similarity in the character, condition and prospects of this and the Union Improvement Company, that what I have said of the one applies in a great measure to the other company. Their charters are alike, with a few exceptions, and these differences are rather in favor of the Big Black Creek Co.

This Company have one thousand acres of land, situate partly in the valley of the Big Black Creek, and partly in the adjoining Anthracite valley of Little Black Creek.

The land is well timbered in both valleys; the water power sufficient for sawmills. The same seams of coal pervade this as the other property. For this land stock has also been issued in payment, and an additional amount authorized to be issued for improvements, all of which has been disposed of.

The work of opening a mine, as here exhibited, is in rapid and successful

progress. The first colliery of this estate may be completed as soon as the tunnel, and the few miles of road over which we have just passed, will be ready for the conveyance to market of the beautiful product that we are now in the act of bringing from its long resting place.

The Big Black Creek Improvement Company have an extensive and valuable coal estate, beautifully and advantageously located, free from debt or other incumbrances, with improvements in rapid progress, including the roadway to market.

The company are now prepared to lease a portion of their lands, and the developments are such as should command good tenants and a liberal rentage.

The Black Creek Improvement Company.—This company also have a liberal charter, and own some 1200 or 1300 acres of valuable and well timbered coal lands in the valley of Little Black Creek, and on the adjoining ridge, where a part of it is still covered by the coal measures.

The company have not yet made any preparations for mining, though they have recently shown some evidences of life by boring into the hills.

The Lehigh and Luzerne Railroad Company.—The charter of this company authorizes a capital of $750,000 and a mortage loan of $250,000, with ample privileges and immunities.

Their point of commencement is on the Hazleton Railroad, about eight miles from Penn Haven, on the Lehigh river.

Four miles of road are laid to Fillmore, over which is carried the coal mined at the extensive works of Messrs. Sharp, Leienring & Co., who expect to send more than 100,000 tons to market this season.

A tunnel through Council Ridge is in course of construction. It will be 1000 feet in length, with sufficient width for two tracks, and the open cuts from grade to fifty feet in depth are 2000 feet long. This formidable and tedious work is now making good progress, and more than half of it is accomplished.

From the tunnel the line curves across the valley, which is followed down five miles to this point, the grading of which is under contract. From this colliery (No. 1 of the Big B. Creek Improvement Co.) it is intended to extend a branch around the hill, at an easy grade, into the coal basin north of us, where are coal lands of this company, of the B. C. I. Co., of Judge Porter, Judge Coxe and others.

Along Cross Creek, near the town of Yedo, another branch line will be run to intersect more eastwardly the same coal basin and its extension, commonly known as the Sandy Creek basin.

The means for constructing the road have been or are to be furnished by subscriptions to the stock, and by a loan convertible into stock.

TUNUNGWANT COAL AND IRON—N. WESTERN PENNSYLVANIA.

Dr. Owen, of New Harmony, Indiana, and Professor Needham of Scranton, were employed for several weeks during the past autumn in examining the mineral waters on the head waters of the Tunungwant and its tributaries in McKean county, Pa., with which the portion of the Buffalo and Pittsburg Railroad, now being constructed, will, it is understood, bring our city into communication some time during the ensuing summer, by the means of other roads with which it will form connections.

We have been favored with an examination of a synopsis of the report made by these gentlemen, accompanied by a drawing of a vertical section of the hills containing the minerals, showing the various strata or veins of coal and iron ores, in their relative positions with the intervening rocks, fire clays, etc., together with an analysis of the different coals and iron ores as made by Dr. Chilton, and more recently by Dr. Owen himself.

That part of the great bituminous coal field of north-western Pennsylvania, embracing the lands forming the subject of the report now under considera-

tion, occupies an extensive plateau whence arise numerous branches, giving origin to the Tunungwant, the Tuanette and the Kenzua creeks.

The two former come together at or near the base of the hills, forming the main Tunungwant, which, flowing northerly, empties into the Alleghany river about twelve miles below Olean, in the county of Cattaraugus, N. Y., while the latter stream rises further to the east—thence flowing in a westerly direction, empties into the Alleghany below Warren, Pa.

The valley of the Kenzua is deep and wide, completely separating the veins of coal and iron, leaving some seventy or eighty, and possibly a hundred thousand acres of mineral lands to the north of it. The elevation of these table lands is from six hundred and fifty to seven hundred feet above the valley of the Tunangwalt at the State line. The branches commence descending rapidly from the summit, cutting out for themselves deep valleys, thus affording every desirable facility for the construction of branch rcads throughout the coal measures, while at the same time they give access to the various strata of minerals by means of horizontal drift.

The report describes four workable veins of coal—one of four, and three of about five feet each, one of which is called Cannel Coal, and the others Bituminous, but differing somewhat in quality, as shown by the analysis, all shown to be of excellent quality, some of it superior, as we judge by the comparisons made with bituminous coals of other parts of Pennsylvania, Ohio, Virginia, Kentucky and G. Britain.

There are also four veins of iron ore, varying from one and a half to five feet in thickness. The three principal veins are described as the Black Band, containing 48·75 per cent. of iron, the Gray Fossiliferous Carbonate, and the Hematitic ore, containing from 45 to 30 per cent. of iron. These ores compare favorably with the ones of Great Britain, which it is well known are so extensively worked. On looking over a table of the analysis of the ores used at eight of the principal iron works of England and Scotland, we find them to range from 28·01 to 41·41 per ct., among which are the celebrated Black Band ores of Scotland.

These mines of coal and iron are within 85 to 90 miles of this city by the direct route, and will be introduced as we have before intimated, during the coming summer, by means of the roads now in progress of construction from the mines to the New York and Erie Railroad, a distance of some twenty miles, thence over the N. York and Erie to Dunkirk, fifty-two miles, and from Dunkirk to Buffalo, by the State Line Road, forty-one miles, or by water, during the season of navigation.

The distance from the mines to this city, via Dunkirk, is one hundred and thirty miles. This is some 27 or 28 miles greater than by the route contemplated for the Buffalo and Pittsburg road, and when that road shall be compléted, it will lessen the cost of transporting coal and other commodities about fifty cents per ton. But we regard the introduction of the coal and iron of the Tunungwant into our city at an early period, in any manner, however imperfect, as a matter of vital importance, believing that when that is once accomplished, these means will be perfected, so that ere long we shall have all necessary facilities for obtaining them at the lowest possible cost.

This report also mentions large quantities of Fire Clay, of excellent quality, suitable for the manufacture of fire brick, and sandstone in great abundance, of the kind employed in the manufacture of flint glass.—*Buffalo Adv.*

COAL-BURNING LOCOMOTIVES.

We are indebted to the courtesy of Mr. George S. Griggs, Superintendent of Motive Power on the Boston and Providence Railway, for the details of some recent experiments in coal-burning on that road, which go to confirm the views we have lately expressed on coal-combustion, and encourage the hope of a speedy and profitable change of railway fuel.

The Mansfield, a Taunton-built freight engine, weighing 52,900 lbs., 16

inch cylinder, with 20 inch stroke, and 5 feet driving wheels, made six round trips on the night freight train, 90 miles each, ending July 9th, with 24,092 lbs. of Cumberland coal. The average number of cars drawn was 41. Putting the cost of coal delivered at $6 25 per 2240 lbs., and the kindling wood, of which one foot was used each trip, at $7 per cord, and we have an expense of about $12 08 per round trip, or 13·4 cents per train mile. The cost of wood fuel, as estimated by Nathan Hale, Esq., on the Worcester Railway returns of 1855, was 41·9 cents per mile of each freight train, and as the average weight of the trains was probably not more than that of the 41 cars drawn by the Mansfield, we may set down to the coal-burning in this case a saving of 68 per cent. in the cost of fuel.

Again, on the same road, the New York, an engine weighing 48,500 lbs., 15 inch cylinders and 20 inch stroke, and 5 feet driving wheels, made six round trips of 90 miles, with 16,624 lbs. of Cumberland coal, drawing an average of 30 cars. Here was an expense of $8 60 per trip for fuel, or 9 1-2 cents per mile of train, or considering the work done, a small gain on the previous experiment with the Mansfield. This experiment was concluded on the 8th July. On the 9th July the same engine, the New York, ran a round trip, leaving Boston at 11 A. M. with the passenger train, and we had the pleasure of accompanying her. She had 6 long cars from Boston to Mansfield, 4 from Mansfield to Providence, 5 from Providence to Mansfield on the return, and 6 from Mansfield to Boston. The time of running each way was two hours, including in the round trip 28 stops. We saw the coal weighed which was taken on, 3,500 lbs., and have no doubt that the weight of the pile left, which we did not have time to see weighed, has been correctly stated to us since as 2,120 lbs., it having been weighed in presence of numerous witnesses. The consumption of coal on the round trip was then only 1,380 lbs. and the whole expense for fuel $4 72, or about 5.2 cents per mile. The average cost of fuel for passenger trains by Mr. Hale's estimate on the Worcester road in 1855 was 20·35 cents per mile. Compared with this, the New York realizes a saving of over 74 per cent.

The Mansfield and New York are both common wood-burning engines, 2 inch tubes 12 feet in length, altered by Mr. Griggs to coal burners by simply inserting an arch or bridge of fire-brick over the grate and under the tubes, across that part of the fire-box next to the latter. This arch or diaphragm extends towards the door of the fire-box perhaps one third of the way, and the effect is to throw forward or reverberate the flame and gases from the combustion of the thin stratum of coal that is projected under the bridge, and create an eddy in the fire-box, and thus mixing the air and gases to cause sufficient detention for a more complete combustion before the current enters the tubes. The coal, more heaped towards the door, gets heated up and partially coked before being pushed down under the heated fire-brick arch for final combustion. This experiment certainly indicates a quite effective combustion, and it only remains to test whether it is the best way of applying the reverberating principle for the permanence of the parts of the boiler most exposed to the heat. A perfect coal-burner must combine with the most thorough combustion of the fuel, that distribution of the heat to the steam generating surface which will produce the least inequality of strain or wear on the boiler. This will give additional interest to the trial of the new coal-burner of the Franklin Locomotive Company soon to be made on the Fall River Railway, which differs from this arrangement of Mr. Griggs only in having the fire-box more extended horizontally, and making the reverberation further forward by a bridge in a different position. Though it strikes us that in the essential thing which involves the solution of the coal-burning problem, that is, *reverberating by a bridge or curve*, these two arrangements are identical, we are not prepared to say till we see more extended experiments, embracing time enough to settle the question of wear, which may have the advantage in regard to the minor differences we have specified.

One advantage of the arrangement of Mr. Griggs is obviously in the heat-retaining quality of the fire-brick which he uses, which tends to equalize the temperature of the fire-box and prevent the depressing effect of a fresh supply of fuel. This is doubtless of much greater importance than the common practice in coal-burning experiments would lead us to believe. It can hardly better be dispensed with than the fly-wheel of a rolling-mill, and especially when we attempt to burn coal in a thin stratum.—*Railway Times.*

ON COKING AND COAL WASHING.

At a lecture delivered before the Bristol School of Mines, the lecturer remarked that two things were to be regarded in the burning of coal—distillation and combustion. Properly speaking, we could not burn coal; when submitted to a high temperature, distillation took place, and certain gases were liberated, leaving coke behind. The process of manufacturing gas consisted in the distillation of coal; but when a superior kind of coke was required, as for railway and other purposes, it was necessary to effect a very gradual distillation by a minimum temperature necessary to the process, and by burning the gases eliminated, so as to retain as much carbon as possible in the shape of coke, carbonic acid, and carburetted hydrogen being then given off, instead of carbonic oxide and carburetted hydrogen. Our terms bituminous and non-bituminous coal, were calculated to lead to some amount of error, as there was in reality nothing specifically making this distinction; and as we advanced in acquaintance and utilisation of the mineral, it would be necessary to form a nomenclature. The terms adopted on the continent were caking, sinter, sand and anthracite,—caking being the name given to the coal which fused together; sinter that which separated into pieces, and but imperfectly fused together; and sand to the form which the coal retained. The remark that the coking property of coal depended on the proportions of hydrogen and oxygen it contained, seemed to hold good with respect to three kinds of coal,—sand coal, the least coking, being represented by C 80+H44+O, sinter C 80+H 64+O 8 to O 6; coking, C 80 H+ 120+O 5; but the kind termed high coking, seemed to form an exception to this remark, as it was represented by C 80+H 56+O 3; in this case there was a diminution of oxygen, and yet an increase in coking property. The clinkers in coking were formed by carbonate of lime forming a flux with iron pyrites; the sulphurous products caused waste of firebars, or any other iron with which they were brought in contact; it was the sulphur in the gas that tarnished plated goods in houses. Defects in the methods of coking consisted in an imperfect combustion of the volatile parts; the greatest quantity of tar was formed at a temperature of 700°, and the least quantity of gas given off; a higher temperature eliminated a greater quantity of gas to the destruction of much of the coke. The great difference between other coke ovens and that of the lecturer's, was, the air being carried down through the coal in the latter, and up in the former. The point gained was that of carrying the bituminous tarry products from successive layers of newly supplied coal down through the coke of high temperature, and so securing a portion of their carbon, which would otherwise have been volatilised, thus saving a percentage considerably greater than that by other methods. It was of great importance that all the earthy and stony impurities were removed from the coal prior to coking. After the introduction of a French patent into England for washing coal, by Mr. Morrison, the coal of the old heaps of the north of England was converted into coke, and used to run express trains with. Much of the coal left as waste under ground, might be brought to bank and washed at a total cost of 2s. 6d. per ton, and could then be sold at 5s. per ton. Coal was washed by its being kept agitated in water, so that its impurities, being of greater specific gravity than the coal itself, sunk to the bottom, whilst the coal was found at the top. In the method of washing by a plunger at the end of a box, the water was

not only forced up, but pulled down, through the coal, thus tending to mix the heavier particles of coal with the shale. By the lecturer's recent invention, this effect was obviated in the use of a centrifugal pump, by which a continuous upward current was maintained in a conical hopper, down through which the shale and stony impurities fell into a receiver, whilst the coal was scooped over the top of the hopper into a conductor. Mr. Mackworth exhibited various interesting and instructing models, showing defects in present washing machines and coke ovens, and how such might be remedied.

OHIO CANNEL COAL AND COAL OIL.

A company has been organized, and has purchased a considerable extent of cannel coal lands in the counties of Coshocton, Muskingum and Licking, in Ohio. Some of the seams are seven feet thick, and the coal is of the best quality. This company is now erecting substantial brick buildings in Newark, Ohio, for the manufacture of coal oil, and also to supply that city with gas. These works are expected to be in full operation in the month of September next.

CANDLES FROM IRISH PEAT.

It will be remembered that in 1854 Dr. Sullivan, the chemist to the Museum of Irish Industry, made a careful inspection of the works of the Irish Peat Company at Kilberry, and published an elaborate report upon the products of the destructive distillation of peat. In that report it was stated that a proposition had been made for preparing paraffine from the tar, which was one of the resulting products, and for obtaining from the aqueous liquor naptha, sulphate of ammonia, and acetate of lime. In the separation and purification of these products heat would naturally play a very important part, and a considerable quantity of fuel would be required, but by a very happy arrangement the fuel would be supplied by the gases which would otherwise be wasted. These waste gases it was proposed to employ as the sole fuel for raising steam to work the blowing cylinders for distilling the tar, in the purification of the oils and paraffine, and in the separation of the other products. It was anticipated that the paraffine could be advantageously used as a substitute for spermaceti in the manufacture of candles, and a number of marketable oils. So far as regards the manufacture of candles, considerable difficulties were experienced in obtaining the requisite amount of whiteness and transparency. Messrs. Field, however, have succeeded in overcoming all obstacles, and were enabled at the recent meeting of the Irish Peat Company, to exhibit candles made from the paraffine produced by that company, which had every appearance of the most superior sperm, whilst it is believed that they can be manufactured at a much lower price. The paraffine oil, which appears to be solid paraffine dissolved in an isomeric oil, is a highly valuable lubricator for machinery, and is coming into extensive use in the manufacturing districts.

SCHUYLKILL COAL TRADE.

The quantity of coal sent by railroad and canal from Jan. 1 to July 23, 1857, is:—

	Tons.
By Railroad	1,078,874·11
" Canal	558,643·03
Total by Canal & R. R.	1,637,517·14

Shipments to same period last year:

By Railroad	1,186,180·11
" Canal	526,382·06
	1,712,562·17
	1,637,517·14
Decrease in 1857, so far	75,045·03

LEHIGH COAL TRADE FOR 1857.—*From Miner's Journal, Pottsville.*

Total amount of shipments for 1857, to July 23d:

By Canal,	Tons.
Lehigh Coal and Nav. Co.,	149,599·11
A. Lathrop and others	1,403·13
Spring Mountain Mines	15 550·04
East Sugar Loaf do	7,172·12
Coleraine do	21,393·09
Stafford do	510·11
N. York and Lehigh Coal Co.,	10,918·06
German Penna. Coal Co.,	6,108·13
South Spring Mountain Coal	6,651·02
J. B. McCreary & Co. N. S. Mt. Coal	2,918·17
Hazleton Coal Co.,	38,340·09
Cranberry Mines	22,829·19
Diamond Mines	10,727·04
Council Ridge	15,659·12
Mt. Pleasant Coal Co,	1,173·06
Buck Mountain Coal Co.,	35,755·15
Wilkesbarre Coal Co.,	538·18
Wyoming Coal	4,436·08
Hartford Coal Co.,	11,299·05
Total	362,987·14

LEHIGH VALLEY R. R.

Spring Mountain Mines,	65,241·05
East Sugar Loaf do	51,114·09
N. York & Lehigh do	21,824·03
Council Ridge do	36,420 12
German Penna. do	4,496 07
Coleraine & Stafford do	29,685·00
Dolbin & Dehaven do	3,529·17
Hazleton do	21,415·04
Total	236,085·12

Shipments during same period, last year:

By Railroad,	67,699·01
By Canal	503,293·08
	570,992·09
	599,073·06
Increase in 1857, so far	28,081·15

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the Month of July, 1857:

	Month.	Total.
Union Canal	21,416·04	77,567·01
Swatara Railroad	14,942·03	58,021·14

LYKENS VALLEY COAL TRADE FOR 1857.

	Total.
Lykens' Valley Coal Co.	28,741
Short Mountain Co.	22,286
Total,	51,027
Freight and toll from Millersburg to Baltimore,	$2 10
" " Pinegrove "	2 10

If cars are detained 24 hours after arrival, the rates are 12 cents additional to the above.

SCRANTON COAL TRADE FOR 1857.

Shipped North	104,866·07
Shipped South	169,169·13
	274,036·00
To same period last year, (South)	11,914·04

DELAWARE AND HUDSON CO.'S COAL TRADE.

	Tons.
Up to July 23d, 1857	153,056
Last year	193,659
Decrease this year	40,603

TREVORTON COAL TRADE FOR 1857.

Up to July 23d, 1857	47,039·15

BROAD TOP COAL TRADE FOR 1857.

Up to July, 23d 1857	41,595

PENNSYLVANIA COAL CO.'S COAL TRADE.

Up to July 23d, 1857	217,348·00
Last year	215,129·00
Increase so far, this year	2,219·00

MARYLAND COAL TRADE.

By Cumberland Coal and Iron Co.'s Railroad, to July 18th:

Cumberland Coal & Iron Co.	75,476·03
Percy & Co.	000·00
Ætna C. Co.	8,747·17
Total	84,224·00

By Cumberland and Pennsylvania Railroad:

Frostburg Coal Co.	12,116·12
Borden Mining Co.	35,042·02
Alleghany Coal Co.	20,328·05
Union Coal Co.	721·15
Total	68,208·14

Total from the Frostburg region since January 1st, 152,432·14 tons.

By George's Creek Railroad.

Franklin Coal Co.	21,444·12
Barton Coal Co.	286,08
Swanton Co.	3,433·07
Pickell Coal Co.	4,329·01
American Co.	50,324·19
C. E. Detmold	17,078·19
George's Creek Co.	36,999·10
Total	131,896·16

By Hampshire Coal and Iron Co's. Railroad.

Hampshire Co.	30,374·12

Total from the Westernport region since the 1st January, 163,061·12 tons.
Total from the whole coal region for the year, 315,494·06 tons.

POTTSVILLE MINING AND MANUFACTURING COMPANY.

This company, which was incorporated May 8th, 1857, embraces the following officers: *President*, Richard Jones; *Vice President*, Francis Spencer; *Directors*, Richard Jones, T. C. Zulick, George Spencer, C. M. Straub, Daniel Edwards, John Edwards, Francis Spencer; *Treasurer*, George Spencer; *Secretary*, S. Morton Zulick.

The lands proposed to be opened by this company are those well known as the property of the North American Coal Company, which for a series of years have remained unimproved. They are very valuable, embracing as they do eleven of the most valuable and productive working veins in the southern and central portions of the coal basin. Maps in the pamphlet before us give cross sections of the veins of coal, which exhibit clearly their magnitude and value. The company proposes by shafts to open two or three first class collieries on their lands from a point east of Port Carbon in a direct line to west of Pottsville. As a means of developing the Mammoth and other veins in the basin, beyond the reach of individual enterprise, and rendering property, heretofore unproductive, valuable, we welcome to the field of enterprise in this region, the Pottsville Mining and Manufacturing Company.—*Miners' Journal.*

IRON AND ZINC.

RAILROAD IRON IN THE UNITED STATES.

	Tons produced in the United States.	Consumption, on the basis of 100 tons per mile of new road.		Deficit.
1853	100,000	264,900	2,649 mil.	164,900
1854	110,000	273,600	2,736 "	163,600
1855	125,000	200,100	2,001 "	75,100
1856	150,000	343,000	3,430 "	193,000
		Imported rails reported by Treasury Department.		An'ual stock of rail iron.
1853	100 000	298,995		398,995
1854	110,000	288,866		398,866
1855	125,000	127,915		252,915
1856	150,000	155,995		305,995
	Consumption.	Annual stock.		Stock (surplus) on hand
1853	264,900	398,995		134,095
1854	273,600	398,866		125,266
1855	200,100	252,915		52,815
1856	343,000	305,995		*

The following table exhibits the points at which railroad iron is now made in the United States, and the quantity manufactured by each establishment in the years

	1854.	1855.	1856.
South Boston, Massachusetts	15,000	15,000	16,000
Troy, New York	4,000	10,000	13,000
Trenton. New Jersey	10,000	10,000	15,000
Montour, Danville, Pennsylvania	16,000	19,000	22,000
Rough and Ready, Danville, Pennsylvania	4,500	5,000	5,000
Lackawana, Scranton, Pennsylvania	10,982	13,000	16,000
Phœnix, thirty miles above Philadelphia, Penn.	13,688	14,500	15,000
Safe Harbor, on the Susquehanna, Pennsylvania	10,175	10,607	10,500
Palo Alto, at Pottsville, Pennsylvania	......	500	......
Pottsville, on the Schuylkill, Pennsylvania	1,676	1,700	500
Cambria, Johnstown, Pennsylvania	1,806	11,000	8,000
Brady's Bend, above Pittsburg, Pennsylvania	8,700	600	2,000
Casalo, Pennsylvania	3,800	......	1,000
Mount Savage, Cumberland, Maryland	7,000	7,500	12,000
Crescent, Wheeling, Virginia	7,000	9,000	9 000
Washington, Wheeling, Virginia	4,500	5,000	3,000
Tredegar, Richmond, Virginia	500	......	......
Portsmonth, Ohio	1,500	2,500	......
Cleveland, Ohio	......	......	1,500
Detroit, Michigan	......	......	1,500
Covington, Kentucky	......	......	......

The mills at Cleveland and Detroit have lately gone into operation, and are said to be of a capacity equal to 10,000 or 12,000 tons per annum. Several other mills would have been established at more distant western points, where they are greatly needed, as at Chicago and St. Louis, had sufficient confidence been felt in the stability of the present legislation. Three rolling mills at St. Louis of capacity respectively of 6,000, 3,000, and 1,000 tons, would have been provided with apparatus for rolling rails, but for the same apprehension.

The production of railroad iron in Great Britain is about four times that of

* Deficiency of 37,005.

the United States. The total iron production of that country per annum amounts to about three millions of tons, and the production of the United States to about one million. Great Britain and Ireland has 8,480 miles of railroad, and the United States 21,690 miles.—*Senator Bigler of Penn.*

GERMAN IRON MANUFACTURE.

The increase in the production and manufacture of iron in Germany, within the last few years, says the Augsburg *Allgemeine Zeitung*, is remarkable. In Prussian Westphalia alone, no less than sixteen mining and smelting companies have been formed since 1848—twelve of them since 1854. In 1853 this province produced but 603,525 cwt. pig iron, and 118,064 cwt. cast iron ware, while in 1854 the product was 709,110 cwt. pig iron, and 332,061 cast iron ware, showing an increase of 78 per cent. in one year. In 1855 the same province produced 1,513,039 cwt. pig iron, and 1,126,025 cwt. bar iron.

The product of iron ore in all Prussia in 1853, was 1,496,516 tons, and in 1854, 2,144,149 tons; increase, 647,633 tons. The product of all the furnaces in the kingdom of Saxony in 1852, was 168,175 cwt., in 1853, 170,637 cwt. Bavaria produced in 1850, 668,167 cwt.; in 1853, 1,074,317 cwt. Austria in 1830, produced 1,487,836 cwt. pig iron, and 151,637 cwt. cast iron ware; in 1854, 4,151,505 cwt. pig iron, and 582,446 cwt. cast iron ware. The product of all the furnaces in the States of the Zollverein was:

In 1851	4,612,102 cwt.	In 1853	6,126,458 cwt.
In 1852	5,137,821 „	In 1854	7,501,470 „

showing an increase from 1851 to 1854 of 64 per cent. At this rate of increase, the production of iron will soon exceed its consumption in Germany. But little railroad iron is now imported into Germany. The rolling mills on the lower Rhine, in Berlin and in Silesia, supply Prussia; the rolling mill of Zwickau meets the demand of Saxony, and that of Burglengefeld supplies Bavaria. Austria, too, is supplied by domestic mills. German rails are more expensive than English, but are also said to be more durable.

In regard to machinery, Germany is also making rapid progress, and already outstrips England in the building of locomotives. Not a single locomotive is now sent from England to Germany on German account, whilst numbers of them are sent from Germany to France and Switzerland. Extensive iron foundries and machine shops are to be found in Berlin, Vienna, Munich, Augsburg, Eslingen, Carlsruhe, Aix-la-Chapelle, Ruhrort, Hanover, &c. Up to January 1, 1854, one establishment in Berlin had alone turned out five hundred locomotives, and one thousand three hundred have been built in all in Germany, since 1841. The establishment of Kramer & Klett, in Nuremburg, manufactures an almost incredible number of railway cars, whilst that of Kœnig & Bauer, in Oberzell, near Wurzburg, had, previous to 1855, completed four hundred and twenty steam-presses, among which were quite a number of four-cylinder revolving presses, and one with six cylinders, for the Industrial Exhibition at Munich.

The extensive steel works of Krupp & Co., in Essen, sent to the Paris Exhibition a solid block of cast steel, weighing 10,000 pounds. This establishment has such confidence in its work, that it offers to pay 15,000 thalers damages if any of its railroad car axles shall break within ten years. The same house also manufactures cast steel cannons and bells. The cannons have, after repeated experiments, been declared to be superior to those made of brass or of bronze.

German cutlery is likewise beginning to compete with the English, especially in the West Indies and South American markets. The sugar plantations of the West Indies, which formerly obtained their harvesting implements from England, now import them direct from Germany.

EXPERIMENTS WITH BESSEMER'S IRON PROCESS.*

Several experiments have been recently undertaken on the large scale at the Dundyvan Iron Works and Coats Malleable Iron Works, near Glasgow. The furnace employed at Dundyvan was composed of iron, lined with fire-clay, and it was charged with 13 cwt. 1 qr. and 8 lbs. of No. 2 pig-iron, whilst the air (cold blast) was forced in under a pressure of 15 lbs. on the square inch. The iron commenced to boil immediately, followed by sparks and flame, and the production of much slag or cinder, which caused the furnace to overflow occasionally. The blast was continued for eighty-nine minutes, during which time the scintillations, jets of flame and slag, continued to be evolved. The furnace was tapped, and the iron run into moulds. The quantity of metal found in the moulds was only 3 cwt. 3 qrs. 2 lbs., which, added to that thrown out during the operations, viz: 1 cwt. 3 qrs. 12 lbs., gives 5 cwt. 2 qrs. 14 lbs. as the entire weight of pure iron obtained from the experiment. It may be mentioned that, after half an hour, the pressure of air gradually decreased to 5 lbs., owing to the enlargement of the mouth of the tuyeres, but the latter pressure was still found sufficient to penetrate the molten mass. The time employed in this experiment was unnecessarily long, and undoubtedly was the cause of so much of the iron being burned away. The loss was nearly two-thirds of the original amount, being, in round numbers, 8 parts out of 13. The iron obtained was very crystalline and brittle, and, when attempted to be rolled, at once proved itself to be *hot short*. An attempt was made to anneal this iron, by raising it to a red heat, and then very slowly cooling it, as also by keeping the mass at a red heat for sixty hours, and then lowering the temperature very gradually; but both attempts failed in giving other than a highly crystalline and brittle product. At Coats Malleable Iron Works, a circular furnace, built of fire brick, was employed, which was charged with 7 cwt. of No. 1 pig iron. The cold blast, under a pressure of 12 lbs., which decreased to 5 lbs., was forced through the metal for thirty minutes. The usual display of sparks, flame, and slag was observed, and the furnace being tapped, the iron ran into moulds. The product or *bloom* was highly crystalline and brittle when heated and rolled; as also, when re-heated and re-rolled, the rods obtained from the first and second rollings still retained this crystalline and brittle character. This iron was *cold short*. Another trial with No. 1 pig iron, subjected to a stream of air for twenty-four minutes, gave a similar result; the successive rollings not yielding an iron of a tough character, or fibrous texture. It is worthy of consideration that the quality of pig iron used in these experiments was "No. 1" at Coats, and "No. 2" at Dundyvan. These varieties are more fusible than the others, contain more carbon, command a higher price in the market, and are generally used by the founder, and not by the puddler. The varieties "Nos. 3 and 4" are generally used in the conversion of pig iron into bar iron. One trial has been made at Coats on No. 4 pig iron, but in fifteen minutes the metal settled down in the furnace; and though it was immediately tapped, yet the iron did not run off, and the furnace was taken to pieces to liberate its iron prisoner.

To a certain extent, the ordinary refinery furnace is the equivalent of the Bessemer furnace, as it is quite possible for all the impurities contained in pig iron to be got rid of in the refinery furnace, with the single exception of the carbon. Moreover, when the pig iron is placed in the Bessemer furnace for a short time, in place of the ordinary refinery, and thereafter introduced into the puddling furnace, a very superior bar iron is the result, as proved by an experiment conducted on a somewhat large scale at Coats Malleable Iron Works.

* Official report of a paper read by Dr. Stevenson Macadam, F. R. S. E., at the Royal Scottish Society of Arts.

IRON BACKS ON LODES.

Iron in great quantities has been found in most of our principal mines associated with tin, copper, and lead. To begin with, the St. Just tin mines, Augusta Consols, Wheal Owles, Wheal Boys, Parkenworth, Botallack, and Levant, are all associated with iron to a great extent, as the red clothing and bodies of the miners abundantly testify; or examine the mineral, and iron will be easily detected by the most inexperienced. At Reeth, Reeth Consols, St. Ives Consols, and Wheal Trenwith, iron also abounds in the lodes: these are all oxides of iron.

Mundic, the sulphuret of iron, is always found in large quantities in the backs of lodes yielding yellow ores (the sulphurets of copper), as may be seen at Tywarnhaile, where thousands of tons were found on the backs of the great lode; but, indeed, these instances are so common as to be notorious enough.

White iron (carbonate) is also frequently found in north and south lodes accompanying lead, generally rich for silver, but difficult of separation, being nearly as heavy as the lead ores. At the most easterly mine at present worked, Molland, the whole back of the lode is white iron, in which the copper is found; here the same difficulty exists.

Oxide of iron is also a leading characteristic of the Buller and Basset district, as also Cook's Kitchen, Dolcoath, and Carn Brea, all of which have a vast quantity of iron washed off their ores, both of copper and tin.

I am aware that some persons raise objections to iron in large quantities on the backs of lodes, but that is generally on great coarse north and south veins, and does not in any way refer to the east and west copper lodes, but is frequently made the handle, as in the present instance, to warp the judgment in favor of some other speculation. I think I have shown enough to prove that iron backs are not only numerous, but to be found in our best and most lasting mines; that, therefore, iron backs are not the bugbears they are sometimes represented to be.

I consider a large magnetic iron cross-course, running through a series of copper lodes, to be a good indication, as electric currents may be calculated on, whose influence on mineral veins is so well known, particularly if an elvan be found near, as in the instance condemned.

GEORGE HENWOOD.

PATENT FOR HARDENING IRON AND STEEL.

You noticed a patent for hardening iron. The articles the patentee uses will accomplish his purpose, the prussiate of potash alone being of very great service: 15 years ago I used it with every degree of satisfaction in a certain branch of manufactures, and four months ago I showed its use through the medium of another publication. The *saltpetre* and *sal-ammoniac* he professes to use will not be any improvement in some instances, and in others will be dedecidedly injurious. Hardening steel is a very peculiar operation, and is one of the greatest contingencies in the manufacture of articles into which it is transformed. Under the most careful management I have seen very expensive articles in tools and cutlery rendered perfectly useless through the seeming caprice of the two elements, fire and water; if such articles had been rubbed in prussiate of potash, which gives the metal a sort of liquid case, I think cracking in the water, so common an occurrence with superior articles, would be prevented, particularly if the water used were soft, and by the infusion of a little hot water rendered lukewarm. In hardening iron the very opposite course should be pursued: have the water cold as possible, the harder the better, a little quicklime in it would also be an improvement, and if the iron to be hardened be heated nearly to a white heat, rubbed with or rolled in pulverised prussiate of potash, a steel surface is sure to be obtained.

The objections to the sal-ammoniac and saltpetre are, that they will enter

the pores of the metal, and will afterwards discharge in little particles, which will spread over the surface of the body, and rust the very nature of the mtael away. These three substances would be very injurious to the fire-iron manufacture, which articles are generally case-hardened to make them polish, for all the grinding, glazing, and polishing they might be submitted to would never destroy the effect of the salts in which they had been immersed.

It would be a very great advantage to the agricultural district if their harrow teeth and other iron implements of husbandry were hardened in this way; the cost may be a consideration. I should advise the prussiate of potash pounded, and mixed with horn dust, which would answer better than the salts; the present price (wholesale) is, prussiate potash, 1s. 8d. per lb.; sal ammoniac about 5d., and saltpetre about 4d. per lb. The use of prussiate of potash might be a great improvement to the tools used by miners; their picks and spades would wear longer if hardened with it in the manner I have described. It must be remembered that it is only the surface of the iron which is affected, and the hardening will not penetrate more frequently than the thickness of ordinary tin-plates; but the resistance is so superior to that of iron unhardened that it would be a great saving in the cost of working tools. There is another advantage, it would not render the iron brittle, consequently there would not be an increase in breakage, which is of considerable importance to the owners of extensive workings.—*Correspondent of London Journal.*

IRON NORTH OF LAKE SUPERIOR.

The Detroit *Tribune* announces the departure from that place of the steam propeller Napoleon, with a party of ten or twelve men, under the command of Col. Theodore E. Phelps of Decatur, to open an iron mine on the northern Shore of Lake Superior.

This mine is situated at Gros Gap, three miles from the Hudson Bay Company's post at Michipicoten, one hundred miles above the Sault. The title to six hundred and forty acres of land was issued last year to G. K. Smith, from Her Majesty the Queen of England. The land is all paid for. The ore is so situated that it can be loaded directly on board a vessel, from the mouth of the mine. and varies in richness from thirty to sixty per cent., but with small cost can be dressed to the latter richness. With these advantages, it is supposed a prosperous business will spring up at this point. There is no duty on the ore, and as it is in quantities comparatively inexhaustible, it is hoped this effort to bring it into market will result satisfactorily to all concerned.

DISCOVERY OF ZINC NEAR ALLENTOWN.

This thriving town, in the Lehigh Valley, was recently the scene of considerable excitement caused by the discovery of zinc beds in the bottom land that skirts the Lehigh river in front of the town.

It appears that some days ago, in digging a well midway between the ironworks and the river bridge, and about half a mile from each of these two points, the laborers employed came to a substance resembling the zinc ore found in the Saucon Valley, whence the Bethlehem Zinc Works are supplied; and on examination it was ascertained that a large deposit of zinc ore had been discovered, whereupon the news spread and the curious hurried to the spot. Of course land thereabout instantly acquired in price the upward tendency of the flood tide.

JOURNAL OF COPPER MINING OPERATIONS.

COST OF MINING MATERIALS.

Capt. Paull of the North American Mine, furnishes the *Lake Superior Miner* with the following statement of the kind and amount of mining materials used in the South Cliff Mine, in three months, commencing January 1st, 1857. Also, the number of men in each of the three months, &c.

Months.	Materials.	Amount.	Cost.	Sold for.
January—97 miners and 11 wheelers.	Candles, lbs.	1107	$143 91	$177 12
	Powder "	1450	232 00	261 00
	Fuse, feet	4800	30 00	96 00
	Hand'ls, No.	20	8 00	7 50
	Gad, "	5	1 25	1 25
	Pd'r cans "	4	2 50	3 50
	Shovels "	8	7 36	12 00
	Locks, "	7	1 26	2 62
	Blue clay "	2	4 00	6 00
	Picks, "	6	6 00	9 00
	Gal. oil, "	2	2 50	3 00
February—97 miners and 11 wheelers.	Candles lbs.	1007	130 90	161 12
	Powder, "	1625	259 00	292 50
	Fuse, feet	5100	36 97	102 00
	Hand'ls, No.	15	1 95	4 82
	Gads, "	12	3 00	3 00
	Pd'r cans "	5	3 12	4 37
	Shovels "	4	3 68	6 00
	Locks, "	3	0 54	1 12
	Blue Clay,	2	4 00	6 00
	Picks, "	6	6 00	9 00
	Gal. oil, "	2	2 50	3 00
March—94 miners and 11 wheelers.	Candles, lbs.	878	114 14	140 48
	Powder, "	1669	267 04	300 42
	Fuse, feet	4850	35 16	97 00
	Hand'ls, No.	34	4 50	11 25
	Gads, "	9	2 25	2 25
	Pd'r cans "	4	2 20	3 50
	Shovels "	0	0 00	0 00
	Locks, "	0	0 00	0 00
	Blue clay,	2	4 00	6 00
	Picks, "	4	4 00	6 00
	Gal. oil, "	2	2 50	3 00
			$1,321 53	$1,741 82

The three months materials cost $1,321 53, and sold for $1,741 82, a profit of $240 29, or 31 7–8 per cent profit. This amount of materials performed as follows:

Drifted in all	479 [illegible] feet.
Sunk in all	79 [illegible] "
Stoped in all	120 fathoms,

and gave light for the wheeling and filling of 5470 buckets of mine rubbish, or 2735 tons.

The average number of pounds of candles burnt in January, was 10.2 per man. February 9.3 per man. March 8.3 per man.

Below I give you the second table, showing the amount of wood burnt, and oil used in the same length of time (three months).

Table showing the number of cords of wood burnt, and gallons of oil used in three months by four engines at South Cliff Mine, commencing January 1st, 1857:

Engines.	Cords.	Cost.	Oil.	Cost.
No. 1 Stamps,	308	$539 00	24	$30 00
No. 2 Winding	186	325 50	38	47 50
No. 3 "	111	194 25	8	10 00
No. 4 "	168	294 00	31	38 75
Total....	773	1352 75	101	126 25

Burnt in three months 773 cords of wood in our engines: aside from this we require 300 cords more in the same time to supply our offices, tenements, &c., making in all 1073 cords in three months, at $1 75 per cord would make $1,877 75.

Used in oiling the machinery and lighting the same in three months, 101 gallons oil, which cost at the mine $1,25 per gallon, making $126 25.

Summary.

1 year's mining materials cost	....	$5,286 12
1 " wood "	....	7,511 00
1 " oil "	....	505 00
		$13,302 12

The present working force of our mine, will require all of this amount, and expenses as shown above, to supply our mine with such mining materials as are shown in the table, and the fuel for the engines, &c.

This does not begin to show all of the materials used in and about the mine, and I will here name some other kinds which are not in the table:

1st. Iron, steel, ropes, hemp and other packing for engine pumps, &c. Tallow, tar, pikes, and nails of various sizes; leather, lumber, and small castings of various kinds, and many other things too numerous to mention. These things to a well established mine, amount to a big bill in the year, as much we think as one half of the cost of the materials named above. Say for the North American mine cost of materials shown above is $13,302, 12. Other kinds of materials will certainly cost one half of this amount, making up the bill for the mining supplies alone $19,953 17. This I am well satisfied is a low estimate of the cost of supplying the mine for the year.

This information to our mining men of the country, I do not consider to be worth much, but to the mining companies and those persons unacquainted with the mining business of this country, such statistics may prove to be of some advantage. I can say for myself, that I had no idea of the cost of furnishing a mine with supplies untill I had figured up the items.

IMPROVEMENT IN WASHING ORES.

We find in the Lake Superior Miner the following account of a machine in operation at the stamp mill of the Portage Mine.

The writer says "Capt. Edwards' (the inventor) plan consists mainly of a large oscillating pan or basin, which is so arranged, by machinery rotating horizontally, as to tip in succession every point of its edge. The basin does not revolve. If the reader will take a common dinner plate, place a little water upon it, and, holding in both hands, without lateral motion, tip successively each point of its edge, so that the water runs around in the plate, he will get an idea of the motion given to the water by this machine. The basin or pan which we saw in use is seven feet in diameter. Its form represents the interior of a very flat cone, the height of which is about 15 inches, and the base

seven feet. It has a hole in the centre, closed by a valve or stop cock, through which the fine copper is drawn as the washing process becomes complete.

The stuff is dropped upon the pan from a revolving hopper, without manual assistance.

The centre of the pan remains constantly some two or three inches lower than any part of the edge when depressed to its lowest point. The motion of the water is circuitous, running rapidly around the circle a great many times, with a constant tendency outward, until it finally drops over the edge of the pan. This motion is so adjusted as to carry the rock around the pan with it, and finally to throw it off the edge—while the copper from its superior weight is less affected by the motion of the water, and gradually collects in the centre of the pan, in obedience to its own gravitating force.

The tipping of the pan tends by gravitation to throw to its centre all movable substances upon it—while the centrifugal motion of the water tends to carry all such substances off from its edge. Now the specific gravity of the rock may be set down as something less than 3,—water being one,—while that of copper is more than 8.5—or the copper is about three times as heavy as the rock; and in the water *four* times as heavy. Hence it requires four times the force to move a piece of copper as to move a piece of rock of equal superficies. Skill is therefore required so to arrange the velocity of the water as to carry off the rock without moving the copper. The latter is continually agitated by the stream from the spout, which falls upon it, while the side of the pan is considerably inclined, and the gravitating force constantly throws it upon the centre of the pan. The rock being lighter, is controlled by the motion of the water, and after circling around the pan a great many times, is finally thrown off its edge.

It would be useless, without the aid of drawings, to undertake a description of the machinery, by which the various requisite motions are produced. It is quite ingenious, and in some parts new, though remarkably simple. The cost of a machine of the size of the one now in operation, need not exceed $150 or $200.

The power necessary to operate one of them is trifling, as may be inferred from the work to be done. One horse power would be sufficient for several. The motion given to the revolving apparatus was about seven revolutions to the minute.

The machine which we saw in operation was cleaning the stuff beat up by two batteries, or eight stamp heads. It seemed to clean the copper to about 25 or 30 per cent. purity. This it is well known, greatly reduces the labor of cleaning, and equals the work of several hands. The waste rock, we thought was remarkably well cleaned,—equal to that of any other process.

Capt. Edwards proposes that the stuff should pass over two or more of these pans, one of which should be adapted in its motions, size, &c., to cleaning the rough stuff, and another for the slimes. They have not yet run long enough to determine what number of men would be necessary to operate them, but the inventor thinks that two such machines would take away all the stuff from sixteen head of stamps—say from 16 to 20 tons of rock per day; and that they would require two men and a boy to attend them and to put up the copper.

It is an important and valuable feature in this machine, that the stuff can be passed over any number of them with insignificant expense. The one now in operation promises fine results for the machine. Modifications of its size, motion or other particulars, may improve its action. It would be strange if the first experiment should give a perfect machine. But the thing has great merit, as we believe. A much larger pan may be found necessary—say 10, 15 or perhaps 20 feet in diameter, but the principle seems to be right.

QUARRIES AND CLAYS.

REPORT OF A GEOLOGICAL SURVEY UPON THE LANDS OF THE DICKESON MARBLE AND ZINC MINING AND MANUFACTURING COMPANY OF TENNESSEE.

We have previously referred in these pages to the wealth of this portion of Tennessee in its variety of beautiful and durable marbles. The subjoined report shows with what facilities these marbles can be quarried, and also describes a few of the most prominent varieties.

That portion of Knox county in which are found the extensive deposit of variegated and compact marble, belonging to this company, is situated both in a north-east and south-westerly direction from the city of Knoxville.

The hills and valleys are densely covered by a fine and luxuriant growth of native forest trees, comprising some of the numerous species of oak, hickory, maple, chestnut, pine, beech, locust, gum, and many other species. These, in conjunction with the gracefully swelling ranges of small hills and valleys, present a scene of symmetry and repose exceedingly beautiful.

The East Tennessee and Virginia railroad passes through the entire length of this property, and runs parallel with the marble bed which lies but one hundred feet south of the road; in fact, at one point of the quarry the marble may be craned upon the cars whilst they are resting on the main track.

The main opening, which affords at present so many beautiful varieties of marble, and so highly spoken of by all workers in marble who have seen it, lies only one hundred feet south of the road, towards which the ground slopes gently. The main lead of this marble occurring on the company's property, (which is held in fee simple,) extends in length over a half a mile, and in breadth (not including the wall rocks), one hundred and fifty feet. The width along the lead, depends entirely on the number of the beds or strata, which varies in some places from five to eight feet, each bed averaging from fifteen to twenty-five feet in thickness, increasing invariably in width, compactness, and beauty as it descends.

These several beds are separated by thin layers of rich, red, friable loam, which facilitates greatly in wedging out blocks of large dimensions. It is much more uniform than is usual to veins of this character, and quite as much as it is desirable to find.

The lead runs as far as I was enabled to ascertain, N. 43° E., and dips to the south, and forms a distinct system of veins, running chiefly in the same direction with the elevation or ridge. The dip of the layers cannot be set down with any very great degree of accuracy, those nighest the centre elevation are nearly perpendicular, while those near the edge incline more nearly to the horizontal.

They lie parallel, and with some exceptions bear the same inclination, and maintain the same width of enclosing walls.

The walls are composed of a fine bluish gray compact limestone, easily yields to iron instruments; it varies in thickness from thirty to sixty feet, and burns into the finest kind of lime, which readily sells on the premises for ten cents per bushel.

In architecture it acquires a sufficient hardness to resist any impression of the air or water. The solidity of it, and the ease with which it is wrought, gives it great advantages. Exterior to this, we find a tender stone with a coarse grain, laying in beds from five to eight feet wide. Caverns of immense size completely studded with beautiful stalactites and stalagmites of immense size occur throughout the limestone.

The marble, of which I shall now speak, consists of upwards of twenty

distinct varieties, most of which is composed of the remains of shells and zoophites, formed by a calcareous cement into a beautiful and variegated marble. It bears the highest degree of polish, and is elegantly marked by the sections of the shells and corals which it contains. Their constitutent substance is a white crystallized carbonate of lime; and their cavities are commonly filled with the same substance, presenting a striking contrast to the dark ground of the marble.

Of the varieties, I shall speak of a few only of the most prominent: at the north-east end of the lead, we find a beautiful deep reddish brown marble, with white and gray spots of zoophytic remains. This I shall take the liberty to designate in my description as the *Rosso Antico*, or the Ancient Red. It occurs in immense beds, very clear from faults, and can be wedged out in any size from ten to forty feet long, and fifteen feet wide, and admits of the highest degree of polish. It presents through its structure beautiful groups of madriapores and shells, chiefly the pectinites; but they have assumed the nature and grain of the marble; and the shells seldom appear in their original form.

To enumerate all the shells contained in this marble would be infinite; it will be sufficient for the present to say, that they are of those fish which are called Pelasgic, or Oceanic, and inhabit the unfathomable depths of the ocean.

The Zoophytes are of many varieties, among which may be named the Milleporite, the Celleporite, the Entrochite, the Coralite and Encrinite. It occurs in immense ledges, and may be pronounced inexhaustible; thousands of tons may be removed before having to penetrate more than a few feet below the surface. A noble specimen of this variety may be seen at the Exchange Reading Room, Philadelphia, wrought into an elegant mantelpiece, at the steam marble works of Eli Hess, which, for workmanship and beauty of design, cannot be surpassed in the United States.

Another variety of red marble cccurs in great abundance at this quarry, which I have designated as the *Rouge Antique*. It is much lighter in color than the Rosso Antico, and contains less shells and Zoophytes, but is not less beautiful; by many it is much admired for its crystalline form and delicate tint of red and brown.

This resembles the celebrated red marble of Caen, in Normandy, and of which beautiful mantels and table tops and other ornaments abound in that capital.

One variety of this marble is of a fiery red, mingled with white, disposed in convolved Zones: this marble is also susceptible of the highest cast of polish, and masses of any required size can be obtained. The eight columns which decorate the new triumphal arch, in the Carrousel at Paris, are of this variety of marble, which is one of the finest of France. Columns of this beautiful variety of marble, from Tennessee, are in process of erection in the halls of the wings of the United States Capitol.

Lumachelle.—This is of a deep brown color, and contains a number of shells, mostly fragmentary; forming little clusters, which appear with greater brilliancy from the contrast of the base. The quantity is inexhaustible, and like the above described, admits of a fine polish. The Zoophytic marbles present varieties at once uncommon and beautiful. A fine kind occurs in great quantities, of a chocolate brown color, with numerous white and red Madriapores of various sizes and descriptions. Specimens of this variety may be seen in the cabinet at the office of the company.

Castellini.—This unique marble occurs much more extensive than all the varieties except the *Rosso Antico*. It lies next to the wall rock, and contains but few if any fossils. Blocks from ten to fifty feet, entirely clear of fissures or faults, may be obtained with the greatest ease if required. Its color varies in different localities; the one most common is of a light fawn ground, studded with small dots and patches of light red and pink, and crystalline angular patches of pure white. It admits of the highest degree of polish, works free and clear of seams.

By the plainer class of citizens this marble is much admired, and is well calculated for furniture and mantel-pieces.

In France a similar marble forms most of their mantels and table tops, and is dug near the river Neste which joins the Garonne. Patrin says, large blocks have been raised at an enormous expense, for the decoration of the royal palace of France.

Zebra or *Jasper Marble*, to which this name is given, on account of the clear and distinct layers of different colors, undulating with salient angles like the Zones of fortification agate. The formation of these zones is owing to a play of crystallization, like that of agate, and in like manner they are always found exactly parallel among themselves, whatever may be the irregularity of their course. Some portions are formed in sheets on horizontal planes; and then these layers describe straight lines which are of lively marked colors, such as the white and red.

Sometimes it occurs of a uniform fawn color, mingled with brown parallel veins; this variety admits of a high degree of polish. The only account we have of marble of this character among the ancients, was a column about twenty-four feet in height, found near the Appian-Way, and placed in the library of the *Vatican;* the same which is now in the museum at Paris.

The next property of which I shall speak owned by the company, is situated on the south side of the river Holston, one and a half miles from the city of Knoxville, and immediately on the Knoxville and Charleston Rail Road, and contains three hundred acres of land.

The marble belt passes through the centre of this tract, similar to the one just described, and equally as extensive but not as many varieties. To enter into a minute description of the varieties, would be but a useless repetition of the former.

Suffice it to say that in the almost immediate centre of this marble bed, occurs a fine vein of zinc ore five feet wide in the outcrop, and dips nearly vertical.

It may be traced by the outcrop or gossan, which is composed of a spongy carbonate of zinc, traversing the hills for several miles, on its way to that immense deposit at Mossy Creek and Powell's Run. A sufficient number of leases have been secured to the company to afford any amount of ore required, both silicate and carbonate, when they are ready to commence smelting operations. In my general report I shall dwell more minutely; for the present, this simple description of the quality and quantity must suffice. I cannot conclude this report, however, without expressing my conviction and unabated confidence in the immense profit that will result in the opening of this inexhaustible quarry.

The immense quantity and superior quality of this marble, is calculated to excite the most sanguine expectations; and to raise the confidence which has been generally felt by all who have seen it, as to the value of this property.

With the present very large amount of marble quarried at so small a cost, and the other fine property on hand, the comparative trifling amount required for surface expenditures in future, and the expectations based upon the numerous railroads about being completed in its vicinity, with the great beauty and quantity, with all this I do not hesitate to say, that the time has arrived at which these quarries are capable of declaring large dividends.

The actual cost of transportation at this time to Philadelphia, is but twenty-five dollars per ton, but with intelligent management and a small outlay of capital the transportation can be considerably reduced.

The subject of marbles is almost infinite, as no mineral substance affords such innumerable diversities, or has so much attracted the attention of mankind. The term marble was originally applied to any mineral substance capable of receiving a polish, and used in consequence of the beauty of its appearance for ornamental purposes. At the present time it is applied to such mineral substances only, as from the nature and proportions of their constituent parts are denominated Carbonates of Lime.

The term limestone also, which strictly speaking is applicable to any natural compound containing a large proportion of that earth, is now used to express those natural compounds only, in which lime combined with carbonic acid, is the principal constituent part.

In this sense then, marbles and limestones are, with respect to their chemical analysis, the same; they differ only in their uses and external characters.

Marble, however, may be distinguished from limestone by superior weight, and by superior hardness, so that it assumes a bright polish. It chiefly consists of about fifty per cent. of lime and forty of carbonic acid, and thence it is called carbonate of lime.

In a scientific point of view, marbles may be divided into four principal structures; the *Granular*, the *Compact*, the *Chonchitic*, or that containing shells, and the *Zoophytic*, or that with Madriapores, etc.

The Greeks and Romans were the first nations to introduce the marbles into their architecture. The Egyptians employed the eternal Granite and Basalt. It is well known from many examples that the Romans transported obelisks and columns from many countries to adorn Italy.

In general the ancient and finest marbles belonged to the granular description; it seems evident, though it has escaped most antiquarians and mineralogists, that of all the antique marbles known to the Egyptians, Grecians and Romans, none were held in higher estimation than the superb *Rosso Antico*, which in the grand statues of Agrippa, (formerly in the Pantheon,) the Antinous, Indian Bacchus, and other exquisite remains, surpasses in beauty all the other marbles. This marble was from Egypt, and even in the time of Pliny, was carefully distinguished from porphyry, which came from the same place.

The Rosso Antico, or ancient red, says Pliny, is often sprinkled all over with white dots, and sometimes with little tufts or flowers of white. Brand describes this beautiful marble as of a deep reddish brown, with little distinct black and white patches, and often sprinkled with small white dots. Antinous, the bust of the Indian Bacchus, the celebrated Statue of Agrippa, son-in-law of Augustus, in the Grimani Palace at Venice, are of this imperial marble. In the Museum at Paris, and other princely collections, there are many Egyptian statues and other monuments in the Rosso Antico, the ancient red, the peculiar marble of upper Egypt or Ethiopia.

MONTROVILLE W. DICKESON, M.D.

MISCELLANIES.

PRODUCTION OF ALUMINIUM IN A PRACTICAL AND COMMERCIAL FORM.

Mr. Newton has patented in England, a process by which the production of aluminium is reduced to an essentially practical and commercial form. It has hitherto been the practice to effect the reduction of aluminium from its different compounds (single or double chlorides or fluorides) in closed vessels, and in published descriptions on this subject it has been usual to mention the employment of crucibles enclosed in tubes or retorts of fire-clay, coated with alumina. As the employment of these apparatus is attended with disadvantages, the inventors have, in the first place, substituted for such apparatus vessels made of cast or wrought iron, of varying form, but generally approaching that of crucibles, pots, or seggars, in which vessels, the reaction is effected in the same manner as in vessels of clay. The inventors of the present improvements have also succeeded in effecting the reduction in chambers made of brickwork or fire-clay, which may be either heated in the same manner as a reverberatory furnace, or by the transmission of heat through the sides. The

apparatus employed by preference, however, is a reverberatory furnace, the bed of which having a portion of it inclined, is arranged in a suitable manner for facilitating the collection of the metal as it is produced; but the furnaces ordinarily employed for the manufacture of soda may be used for this purpose. Another improvement consists in modifying the composition of the mixture of matters for effecting the reaction in such a manner as to ensure successful operation, even when operating upon small quantities of materials, or with vessels of small capacity, such as clay retorts or other closed vessels. This is is effected by wholly, or to a great extent, dispensing with the marine salt, which is usually added either to the simple chloride of aluminium, the double chloride of aluminium and sodium, or to the fluoride of aluminium and sodium (cryolite), and in simply adding a suitable proportion of fluoride of calcium. The use of marine salt has been hitherto considered necessary for the successful performance of the reduction, and indispensable as a flux for causing the metal to unite; in operating with the double chloride of aluminium and of sodium it had been pointed out, and always employed in the proportion of 50 per cent. to the double chloride. It has been found by experience, that by diminishing this proportion better results are obtained, and by dispensing with the marine salt altogether, the largest quantity of metal is obtained. The following is the mode of operating, according to this improvement, when it is required to effect the reduction of the double chloride:—Take of the double chloride of aluminium and of sodium, 100 parts; fluoride of calcium, 50 parts; sodium, 20 parts. (These proportions may, however, be somewhat varied, according to circumstances.) These substances having been mixed together, are introduced upon the bed of the furnace, previously heated to redness. The fire bars having been well fed with fuel, the furnace is closed. The reaction will then take place, and by agitating the materials all the aluminium will be collected in a mass, at the inclined part of the bed, and may be run off therefrom By first pouring off the whitest and most fluid portion of the scoriæ, composed chiefly of the marine salt, which has been produced by the reaction, the fluoride of aluminium (which is also an accessory product of the reaction) may also be extracted therefrom. The appearance of the scoriæ remaining is very peculiar; after cooling it is slightly tinged with a color approaching a yellowish gray. This scoriæ does not contain the finely divided aluminium powder which is met with when the reaction is produced with marine salt; it only contains sometimes globules of aluminium, in sufficient quantity to enable it to be collected by pulverizing and washing the mass. When, on the contrary, marine salt is employed, the mass of scoriæ is of a decided deep gray color; this arises from the aluminium powder mixed with the mass, in which are found only microscopic globules, which are at first difficult to collect and unite by melting.

IMPROVEMENT IN ROCK DRILLING.

The London *Builder* gives the following description of an improved rock drilling apparatus:

"M. Kind, the German engineer, has devoted the last twenty years to the improvement of an especial branch of his profession—namely, the boring of rock to great depth. The main feature of his improvement, consists in this: that the boring chisel is fastened to a ramrod of 5 to 6 cwt., which is alternately elevated to a height of 1 or 2 feet by a wooden rod, and thus falls by its absolute weight on the rock, by which even the hardest is reduced to powder. In the old apparatus the rod was made of iron, which amounted at the depth of a thousand feet, to 100 or 150 cwt., imparted to the falling chisel vibrating motions, which nearly annihilated its action. The wooden rod, on the contrary, swims in the water of the borehole, and rods of from 1,000 to 2,000 feet in length do not considerably augment the weight of the apparatus. The progress of the work varies, according to the quality of the rock, from 1 to 10 feet daily; but hard rocks do not present the like difficulties as soft and loose ones, which must be protected by tubes of strong sheet iron.

EARTH BORING MACHINE.

M. Fauvelle's celebrated machine for earth boring, has a boring head consisting of a wrought iron box about eight feet long, upon the lower part of which is fitted a block of cast iron, in which the chisels, or cutters, are firmly secured. Above the chisels an iron casting is fixed to the bar, by which the boring head is kept steady and perpendicular in the hole. A mechanical arrangement is provided, by which the boring head is compelled to move round a part of a revolution at each stroke. The shell pump is a cylinder of cast iron, to the top of which is attached a wrought iron guide; the cylinder is fitted with a bucket similar to that of a common lifting pump, with an India-rubber valve. At the bottom of the cylinder is a clock, which also acts on the same principle as that of a common lifting pump, but it is slightly modified to suit the particular purpose to which it is applied.

MINING IMPLEMENTS.

France has very few coal mines, but on this very account they have received the fostering care of the Government, and next to those of England, have the best mining implements in the world. Some of the mines are very deep, and in this respect they greatly differ from those of the United States, hence they require to be worked in a different manner. The mines, generally, are more than 600 feet deep—holes bored into the earth so deep, that they would receive two Trinity Church steeples placed one above the other, without leaving a single inch projecting above the surface.—Away down in these subterranean regions the toil-worn miners drudge out a weary life. Some of the mines have stairs for the miners to ascend and descend, but the toil of ascension is so severe—that the more common plan is to raise and lower them in metal buckets, operated by the power of a steam engine. Each pit is divided into two open sections or mouths, by a central partition, and by a *double tow*—a large flat hempen belt—running over pulleys above the pit, the buckets are elevated and lowered. While one bucket is ascending on one side filled with miners or coal, an empty bucket is descending on the other side. Many accidents, in spite of great care, have occurred by belts breaking, and dashing the ascending and descending miners to pieces down the terrible declivity. In order to avoid such accidents, a new and ingenious apparatus was exhibited by V. de Brunelle. It consisted of two upright iron shafts, the one alongside of the other, secured in the pit or mine, and extending from the top to the bottom. About every three feet apart, there was a little balcony on each shaft from top to bottom, and when a miner stepped on one balcony to ascend, on the one side, it was elevated by an intermitting motion, and then a balcony on the other shaft descended the same distance, and thus a perfect rotation of ascent and descent was performed by these balconies on the two shafts. Buckets of coal were placed on these balconies, and elevated in the same manner as the miners, thus forming a complete and entirely different plan from working the pit with endless belts running over pulleys. The plan struck us in a very favorable light as being much the safest, although the most expensive. Some of our American mines will yet be as deep as those in Europe. When this takes place, we hope our mine owners will not forget to adopt this humane invention.

GEOLOGICAL FORMATION OF THE GREAT CAVE IN CALAVERAS.

Mr. Wm. P. Blake, recently attached to Lieut. Williamson's surveying party, and who returned a few days since from a visit to the great cave in Calaveras county, has furnished the Times and Transcript with the following account of its geological formation.

The Cave in Calaveras county, which has attracted considerable attention by reason of its extent and the beauty of portions of its interior, is about twelve miles from Murphy's, and fifteen from the grove of mammoth trees.

Rich placers are formed in the immediate vicinity of the cave, and mining is conducted with energy and success. The visitor will find accommodation in the adjoining town called Cave City, or at the house erected for the purpose near the entrance of the Cave.

This Cave is in a hard crystalline limestone, which is not of secondary age, as has been represented, but belongs to the granitic group of rocks, and is popularly termed *primitive limestone.* It is intercalated with the talcose and clay slates, and forms a wide belt which extends in a nearly north-west and south-east direction through Calaveras county.

This rock is sub-crystalline, and may be called a granular marble. Many places were seen where abundance of fine building stone or slabs for ornamental purposes could be procured. It is thickly veined with light blue lines, which are all parallel, and give a structural character to the mass, that resembles stratification. These lines of structure give a distinct trend to the formation, which is generally north-west and south-east, but at the cave I found it to be north 50° to 75° west, dip east.

Limestones of this character, found embedded in the old slates and granites, are considered by some geologists to have once been horizontal strata laid down under water, and filled with the relics of organic life. They account for their present peculiar crystalline character, and the absence of organic remains, by supposing them to have been metamorphosed by great heat and pressure, so that all their original characteristics have been destroyed. Others conclude that they were formed from igneous action nearly in the condition which we now find them. In either case, they belong to the foundations of the earth, and underlie the superstructure of geological history, which records the birth of animate existence.

The road from Cave City to the Cave house skirts along the base of a ridge of this limestone. The entrance to the cave is near the road, and was cut at a lower level than the natural opening, and resembles a mining tunnel. Within the opening the passage descends gently for twenty or thirty feet, and then expands into an irregular chamber, which communicates by various passages and openings with different parts of the cave.

There are several rooms or chambers, varying in size from twenty feet square to over fifty feet in length. Some of these chambers connect by large open passages, so that they may be considered as forming one continuous cavern. Their form is exceedingly irregular, and the height of the roof does not exceed forty feet.

These caverns in the rocks have evidently been formed by the eroding action of water, either standing in great pools, or slowly flowing in and out. The evidences of this action are visible on the sides and tops of the chambers, which in some places are distinctly marked with water-lines, and in others are eaten away below a certain level, leaving projecting angles and overhanging masses.

Several pools of water of unknown depth are found in different parts of the cave, and there are doubtless many chambers which are thus completely filled. The water used at the Hotel is obtained from one of these pools, near the entrance. It is delightfully cool and clear, and is highly charged with lime. It is evident that there is a constant infiltration of water through the seams of the rock forming the roof, and that it becomes highly charged with lime in its downward passage. This is shown by the great number of stalactites hanging pendant from above, some of them being several feet in length and very perfect in form. In one of the chambers where the stalactites are very numerous they are nearly snow-white, and hang like icicles from all parts of the roof. At many places in the cave the direction and dip of the planes of structure in the limestone were clearly visible; some parts of the limestone having been eroded more rapidly than others, so that long grooves and lines were formed in the roof. It was interesting to observe that long lines of stalactites had been formed on these prominent portions. One of the chambers contains a beautiful grotto, formed by a fringe of broad but thin

stalactites hanging like drapery from the edge of a table-like projection of the rock. These pendants are so thin as to be translucent, and a beautiful effect is produced by lighting up the interior with candles. The light becomes mellowed and softened, as if enclosed in vases of alabaster,

Wherever the infiltrating water has coursed down the sides of the chamber, large and massive accumulations of snow-white lime have been formed, covering up all the irregularities of the walls, and heaping up on the floor so as to resemble a frozen waterfall. The similarity of form and appearance is nearly perfect, and they might be called *petrified cascades*. The floors of the chambers are dotted in many places with stalagmites, that rise like stumps or posts above the general surface. It is hardly necessary to remind the reader that these are formed by the calcareous waters that drop down from the roof. These stalactites and stalagmites are all carbonate of lime, and it is an interesting fact that complete crystallization appears to have extended throughout the lime that has been deposited, in whatever shape it is found. One of the accumulations that resembles a waterfall, is brilliant with myriads of crystalline facets, and reflects the light of a candle in all directions. This mass appears to increase by successive additions upon the outside in their crusts or layers: but the molecular forces appear to bring the particles into mathematical order, and a crystal results. It is, however, frequently the case, that lines of discoloration corresponding with each successive layer of material, will remain in the crystalline mass, and indicate the former shape of the surface.

The crystallization of the stalactites renders them compact and elastic, so that when struck they produce a clear sound like a bell. It is soft and musical, and in one chamber there is a group of stalactites, varying in length and thickness, that give a variety of tones.

In most parts of the cave there appears to be a thick deposit of fine earth or loam upon the bottom. Portions of this earth are crusted over with stalagmite, which makes an apparently solid, rocky floor. There are, however, several places where the soft earth has been washed away from under the crust, and it is left projecting out from the walls, and marked the height of the former surface.

It is desirable that this accumulation of earth should be examined for the remains of animals, which are often found in such places.

A skull of a small carnivorous animal had been taken out not long before my visit. All bones found in such places should be preserved, as they are often remains of extinct species of animals.

This cave does not compare in size or interest with those in Virginia and in the limestones of the Western States; but it presents interesting and instructive lessons in geology, and is a good example of the solvent power of water when charged with carbonic acid. Portions of the cave are beautiful, and those who have not seen the extensive caves of the Eastern United States, will not regret making it a visit.

BITUMEN—ITS USES.

This is a name employed to denote various inflammable substances found in the earth. There are a number of different kinds of it, most of which pass into one or other, from petroleum—the most fluid—to asphalt, which is sometimes too hard to be scratched with the finger nail. Extensive magazines of it are found in various parts of the world.—"Elastic Bitumen" is of a brown color, and erases pencil marks like india-rubber, hence it is called mineral caoutchouc. "Compact bitumen," or asphalt, is extensively disseminated, and is found in great abundance in some of the West India Islands, and New-Brunswick, N. A. It is black, and of a hard resinous appearance. The Pitch Lake of Trinidad yields bitumen in all conditions. Petroleum is fluid bitumen; it is of a dark color, and oozes from certain rocks and crevices in the earth, and becomes solid by exposure to the atmosphere. Naphtha, or mineral oil, is

another variety of it, which becomes petroleum by exposure to the air. Petroleum is common in various parts of the United States, such as at Kenawha, Va., Scottsville, Ky., Oil Creek, Pa., Liverpool, O., Hinsdale, N. Y., and it was at one time collected by the Seneca Indians, and sold in the market as a lotion for rheumatic affections and bruises. It is in the form of petroleum that bitumen is most common in our country, and but very little use is made of it, owing, we suppose, to its pungent smell. In Burmah it is used for fuel and illumination; and mixed with soap, is said to form an excellent remedy for many cutaneous diseases, a protective against the prickly-heat of warm countries; and was supposed, at one time, to be a remedy against cholera.

It is a remarkable fact in the history of the useful arts, that asphalt, which was once so generally employed as a durable cement, should have almost fallen into disuse for thousands of years. It resists the passage of air and moisture, and has therefore a most valuable quality for lining cisterns and the interior of deep cellars. Bricks or stones coated with hot bitumen resist moisture, and are rendered proof against decay by changes of weather. Possessing these valuable characteristics, it is wonderful that it is so little used. Some attempts have been made in this city to make a concrete pavement of it, such as the building on the corner of Beekman and Cliff streets, but for this purpose it is evidently not equal to stone flags, because it has had to be relaid, and now huge cracks are again seen in different parts of it. On the other hand, some beautiful mosaic asphalt pavement, has been laid down in the streets of Paris, and is said to be perfectly successful. All the volatile oil and water should be expelled from bitumen by boiling before it is applied as a cement, or it will not resist the changes of heat and cold well. Many failures in the employment of pitch and bitumen for cement have been caused by neglecting to boil it thoroughly. It is our opinion that iron pipes, coated inside and out with hot bitumen, especially the elastic kind, will prevent incrustation inside and render them very durable. And may not this substance be so manipulated, that it can become a substitute for india-rubber and gutta percha? These vegetable resin gums are becoming dearer year after year, and are only obtained in limited quantities and at a considerable expense. On the other hand bitumen is found in exhaustless quantities, and is very cheap. Can it not, by some chemical process, be rendered as elastic as these gum resins, and as capable of vulcanization? Here is a field, we think, of great extent for chemical experiment, to which we invite attention.—*Scientific American.*

SALT MANUFACTURE IN THE UNITED STATES.

The following interesting letter on the manufacture and consumption of salt in the United States, was prepared by Samuel Hotaling, Esq., a leading salt merchant of New York, at the request of a Committee of the British Parliament:

New York, Tuesday, April 28th, 1857.

Dear Sir:—I have received your letter of the 20th instant, in which you solicit information respecting the manufacture of salt—the quantity made in the United States at each of the works—the rate of freight to the principal ports—the toll paid on domestic and also on foreign salt on our State canals, &c.

The interest I feel in the salt trade of this country prompts me to take some pains to give you the required information; yet the short time I have had since the receipt of your letter, precludes me from answering to your several inquiries with perfect satisfaction to myself, in regard to their accuracy.

I will, however, venture to give you the following statistics, which, from the best information I have been able to obtain, I believe to be mainly correct:—

Estimated Quantity of Salt manufactured in the United States per Annum.

	Bushels.
In the State of Massachusetts (mostly in vatsbuilt along the sea-shore)........	46,000
In the State of New York (Onondaga County), about...........................	6,000,000
In the State of Pennsylvania (Alleghany and Kiskiminetas rivers).............	900,000
In the State of Virginia (Kanawha and King's Works)..........................	3,500,000
In the State of Kentucky (Goose Creek).......................................	250,000
In the State of Ohio (Muskingum, Hocking river)..............................	500,000
In the State of Ohio (Pomeroy and West Columbia).............................	1,000,000
In the State of Illinois...	50,000
In the State of Michigan...	10,000
In the State of Texas..	20,000
In the State of Florida..	100,000
Total..	12,376,000

There are salt lakes in the United States Territories—one in the southwesterly part of Texas, and one or more in Utah, where salt of good quality is found in great abundance.

Nearly all the salt manufactured in the United States is made by boiling, excepting what is made in Massachusetts, Florida, and the Solar Works at Onondaga.

The amount of salt manufactured at the Solar Works of Onondaga, in 1856, was 709,891 bushels. The amount of salt manufactured in kettles in Onondaga in 1856, was 5,258,419 bushels.

When the works (at Onondaga) are generally running, they require 3,000,000 gallons of brine daily, and the supply is not less than 2,000,000 gallons per day for six months.

The annual report of V. W. Smith, Esq., the State Superintendent of the Onondaga Salt Springs, which I herewith hand you, furnishes valuable information in regard to the manufacture of salt, the saline deposits within our State, and such other general information pertaining to this necessary article of animal subsistence, as to render it one of the most accurate and interesting public documents published in our country.

The wells in the Virginia Salt Springs are about 900 feet deep. The wells at Pomeroy and West Columbia are from 1,000 to 12,00 feet deep.

The estimated quantity of foreign salt consumed in the United States and Territories is about 18,500,000 bushels per annum.

The amount of salt consumed in the United States (for various uses) is about 60 pounds to each inhabitant.

The consumption in France is estimated at 21½ pounds; in Great Britain at 25 pounds for each inhabitant.

The cost of manufacturing salt by boiling in Onondaga, as per estimate, during five consecutive years, averages about $1 per barrel of 280 pounds.

The freight charged on our canals on domestic salt in barrels of 280 pounds each from Onondaga to Buffalo, 198 miles, is about 15 cents per barrel over the toll paid to the State, which is one mill on 1000 pounds per mile in the canals. To Oswego, 35 miles, the freight is about 6 cents per barrel over the toll.

The freight on foreign and domestic salt, from Albany to Buffalo, 364 miles, is about $3 per ton (of 2,000 pounds) over the toll. Freight from Albany to Oswego, about 209 miles, is $2 per ton over toll. The freight from New York city to Oswego and Buffalo, *via* Albany, is precisely the same as though shipped at Albany, although 148 miles further.

The toll on foreign salt on our State canals, is 5 mills on 1000 pounds per mile.

The freight on a barrel of salt, from Oswego to the principal ports on Lake Erie (average distance about 450 miles), is 12 cents per barrel. The freight to the principal ports on Lake Michigan, distance about 1000 miles, is 25 cents per barrel. The freight from ports on Lake Erie (say Cleveland and Toledo) to the Ohio river and Cincinnati, is 50 cents per barrel. The freight from Chicago to the Mississippi river and St. Louis is 50 cents per barrel.

The minimum price of salt at the Onondaga works, in 1849, '50, and '51, was from 70 to 90 cents per barrel; in 1852, $1 per barrel; in 1853, $1 12; in 1854, $1 25; in 1855, $1 30; and in 1856, $1 40 per barrel.

The solar salt costs about the same price to manufacturers as boiled salt.

The solar salt weighs about 70 pounds to the bushel (measure). The boiled salt weighs about 56 pounds to the bushel, varying, however, according to the position of the kettles, to a weight considerably above, and also considerably below this standard.

The duty paid to the State of New York on salt manufactured at Onondaga, is always reckoned on 56 pounds—this being the statute bushel—and covers the expense incurred by the State for pumping up the water and delivering it to the premises of the manufacturers.

A salt block at Onondaga, of the largest size, is made of brick, about 12 to 15 feet wide, 4 to 5 feet high, and forming two parallel arches, extending the whole length of the block. Over and within the top of these arches, are placed common cast iron kettles, holding about 50 to 70 gallons brine, placed close together in two rows the whole length of the arches. A fire built in the mouth of the arches passes under each kettle into a chimney, built generally 50 to 150 feet high, averaging from 50 to 70 kettles in each block. A single block, with one row of kettles, is about half this width.

The quantity of salt made in one of these double blocks in the year—say eight months—averages 20,000 to 25,000 bushels of 56 pounds.

The cost of a bushel of salt produced at Kanawha is about 17½ cents.

The price of freight on a sack of Liverpool salt from New Orleans to Louisville, averages about 35 cents per sack.

A good portion of the coarse hard salt imported into the United States from the most southerly islands of the West India group, is kiln-dried, cleansed, ground very fine, and put in small packages for culinary or dairy use. The amount of coarse and fine salt imported into the United States from foreign countries for the year ending June 30, 1856, was 15,403,864 bushels. The amount of domestic salt exported during the year ending June 30,1856, was 698,458 bushels. The amount of foreign salt exported during the year ending June 30, 1856, was 126,427 bushels.—Yours, truly,

SAMUEL HOTALING.

AMERICAN MARBLES.

In West Rutland, Vermont, marble is obtained which has no superior for sculpture in the world, and some of it has been exported to Rome, ordered by Italian sculptors; it has a fine grain, and works beautifully under the chisel. In Great Barrington, in that State, there is a flexible marble, which bends like a bow when wet. Black marble equal to that of Ireland, is found in New York, and verd antique is found in many districts, and in every State, in almost every variety. This latter article, on careful chemical examination, has been found to have for its basis an indefinite mixture of serpentine and greenish white talc; with a silicate of alumina and protoxide of iron and manganese, which serves to render it compact, and probably imparts much of the green color. Some specimens contain, also, actinolite, with talc firmly united, so as to present a close texture and considerable resistance to fracture. The proportion of chrome iron ore in crystalline grains, varies in different specimens, but it is never large enough to seriously interfere with the operations of sawing and polishing.

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MINING MAGAZINE.

EDITED BY

WILLIAM J. TENNEY.

CONTENTS OF NO. III., VOL. IX.

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ART. I.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 7.

(Continued from page 153, vol. ix.)

COMPUTATION. (SURVEYED WITH A LEFT-HAND DIAL.)

No.	Angles and Lines.				Trigonometrical Results.							
Draft.	Degree.	Bearing.	Length.		East.		West.		North.		South.	
			ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
1	282½	12½° N. of W.	59	10	.	.	58	6	12	8	.	.
2	286	16 N. of W.	61	8	.	.	59	3	17	0	.	.
3	264½	5½ S. of W.	33	4	.	.	33	2	.	.	3	2
4	260¼	9¾ S. of W.	77	3	.	.	76	2	.	.	13	1
5	Winze.	9½ E. of N.	24	10	4	0	.	.	24	6	.	.
6	272½	2½ N. of W.	60	9	.	.	60	8	2	8	.	.
7	256	14 S. of W.	52	0	.	.	50	6	.	.	12	7
8	287½	17½ N. of W.	45	8	.	.	43	7	13	7	.	.
9	Winze.	4 W. of N.	36	10	.	.	2	7	36	9	.	.
10	83	7 N. of E.	85	4	84	8	.	.	10	4	.	.
11	77	13 N. of E.	28	5	27	8	.	.	6	5	.	.
12	104½	14½ S. of E.	76	0	73	8	.	.	.	.	18	9
13	90	East.	77	6	77	6	.	.	.	.	.	.
14	92¼	2¼ S. of E.	23	8	23	8	.	.	.	.	1	0
15	99	9 S. of E.	107	2	105	10	.	.	.	.	16	9
					397	0	384	5	123	11	65	4
					384	5			65	4		
			Easting		12	7	Northing.		58	7		

Now we discover, by the foregoing calculation, that our assumed mark in the 40 fathom level is 12 feet 7 inches *too far east* for the central point of the rise against the winze sinking from the twenty, and which was the paramount object required.

NOTE.—As the last draft (reversed) is 9° N. of W., in order to be quite accurate, it will require us to measure 12 feet 9 inches back through the level to make good 12 feet 7 inches westing, and this will give 1 foot 10 inches more of base or northing, which, added to 58 feet 7 inches, the underlay shown, by the column of northing will give the answer to the question, 60 feet 5 inches for the whole underlay.

The first operation in working this problem is to find the base and perpendicular of the two winzes, numbers 5. and 9., and their respective bases form the operative lines in the above traverse.

	ft.	in.		ft.	in.	
Winze No. 5. gave	24	10	base, and	60	1	perpendicular.
Winze No. 9. gave	36	10	base, and	60	1	perpendicular.
				120	2	

Now the vertical depth being 120 ft. 2 in., and the base or northing 60 ft. 5 in., we have thus the two sides of a right-angled triangle to find the hypothenuse and dip or angle of declination, which on trial will be found—

Hypothenuse, or length of winze, 134 feet.
Angle, or underlay of winze, 26¾ degrees.

PROBLEM.

A tunnel has been commenced at the foot of a hill, and is intended to be driven through it.

The bearing from the above point, or the course of the tunnel, is to be due east, and it is required to know the exact corresponding point on the other side of the hill, in order to set another company of men to drive a *dead* level to meet the drivings that are progressing from the west side.

The length of the tunnel is also required.

The following is the survey from the first point.

No			deg.		ft.
No	1	Elevation	14	Length	26
	2	——	12¼	——	26
	3	——	11	——	17
	4	——	18¼	——	90
	5	——	10	——	60
	6	——	7¼	——	119
	7	Horizontal	0	——	29
	8	Depression	5¼	——	28
	9	——	16	——	230

Judging that we have now arrived somewhere near the level or horizontal plane of the start, or that our "depressions" have made good our "elevations," we place an assumed mark at the end of the last or 9th draft, and retire to work out our lines and angles by trigonometry.

OPERATION.

			Perp.		Base.	
	fath.	ft.	ft.	in.	ft.	in.
No. 1 Elevation 14 deg. Length	4	2 Tabulars	1	5·4	5	9·9
				4⅓		4⅓
			5	9·6	23	3·6
				5·8	1	11·3
			6	3·4	25	2·9

Thus we find the 1st draft gives a rise or elevation of 6 feet 3·4 inches, and base or horizontal length 25 feet 2·9 inches; and proceeding in the same manner with all the drafts, and finding the difference between the elevations and depressions, we shall obtain true data for correcting our assumed mark, and replacing it in its proper position.

		Elevation.			Horizontal.	
		ft.	in.		ft.	in.
No. 1	gives	6	3·4	and	25	2·9
2		5	6·2		25	4·9
3		3	2·9		16	8·3
4		28	6·0		85	4·0
5		10	5·0		59	0·1
6		14	8·5		118	1·0
		68	8·0			
7					29	0·0
		Depression.				
8	gives	2	8·2		27	10·5
9		63	3·8		220	3·0
		66	0·0		606	10·7

Now as the depressions are 2 feet 8 inches less than the elevations, it demonstrates that our assumed mark is 2 feet 8 inches too high, and as the declination of the ground from the last draft eastward continues on the same angle of depression of 16 degrees, we have perpendicular 2 feet 8 inches and angle 16° to find the corresponding hypothenuse and base; and by inspection of the 2d table we see that the "tabulars" opposite 16° are 1 foot 8·6 inches, and 6 feet 2·9 inches hypothenuse.

Therefore, if 1 foot 8·6 inches give 6 feet 2·9 inches, what will 2 feet 8 inches give?

Which will be found to give 9 feet 8 inches of hypothenuse.

And by the 1st table it will be found that 9 feet 8 inches hypothenuse on an angle of 16° will give for the longest side, or base, 9 feet 4 inches.

ADJUSTMENT.

By removing the assumed mark 9 feet 8 inches, due east on the slope, we fix on the exact spot for commencing the eastern end of the tunnel, and we need hardly observe, that the two extreme marks mean the bottom or floor of the tunnel.

Then by adding the base, 9 feet 4 inches, made by the corrections to the sum of the horizontals, 606 feet 10·7 inches, we have just 616 feet 3 inches for the length of the tunnel.

NOTE.—Should it be required to put down vertical shafts on the tunnel, the foregoing computations reveal what their depths would be respectievly at all parts of the tunnel, and the deepest shaft would be 11 fathoms 2 feet 8 inches at the end of the 6th draft, and 55 fathoms from the western mouth of the tunnel.

PROBLEM.

It is intended to sink a shaft on the end of a level driven from Pendarves' shaft, and the following is the survey from the centre of Pendarves' shaft to the end of the level; viz.

No.	deg.		ft.	in.	No.	deg.		ft.	in.
1	3	W. of N.	45	0	6	6¼	S. of E.	27	6
2	7¼	N. of E.	24	6	7	15	S. of E.	16	5
3	8¾	N. of E.	18	0	8	5	N. of E.	21	0
4		East	49	1	9	12¾	N. of E.	14	7
5	12	S. of E.	30	6	10	9	W. of N.	28	0

As profound accuracy is required in this case (it being intended to facilitate the work by rising against the new shaft from the end of the level), a reverse or proof course of dialling has been made from the end back to the centre of Pendarves' shaft; viz.

No.	deg.		ft.	in.	No.	deg.		ft.	in.
1	8¼	E. of S.	26	10	6	1½	S. of W.	44	0
2	11	S. of W.	15	0	7	7	S. of W.	26	0
3	4	S. of W.	19	6	8	9	S of W.	22	8
4	13¼	N. of W.	20	0	9	2¼	E. of S.	43	10
5	9¼	N. of W.	52	3					

It is now required to know if there is an exact agreement between these two surveys, or fore and back diallings (or what is the difference between them), and if so, what is the length and bearing from the centre of Pendarves' shaft, at the surface, to the point exactly over the end of the level where the centre of the new shaft must be fixed?

OPERATION. FROM PENDARVES' SHAFT TO EASTERN END.

No.	Angles and Lines.			Trigonometrical Results.							
Drafts	Bearings.	Lengths		East.		West.		North.		South.	
		ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
1	3° W. of N.	45	0	.	.	2	4·2	44	11·2	.	.
2	7¼ N. of E.	94	6	94	3·7	.	.	3	1·1	.	.
3	8¼ N. of E.	18	0	17	9·6	.	.	2	7·9	.	.
4	East	49	1	49	1·0	.	.	.	.	.	.
5	12 S. of E.	30	0	29	4·1	.	.	.	.	6	2·8
6	6¼ S. of E.	27	9	26	9·6	.	.	.	.	3	2·1
7	15 S. of E.	16	5	15	10·3	.	.	.	.	4	3·0
8	5 N. of E.	21	0	20	11·0	.	.	1	10·0	.	.
9	12¼ N. of E.	14	7	14	3·0	.	.	3	1 1	.	.
10	9 W. of N.	28	0	.	.	4	4·6	27	7 9	.	.
				198	4·5	6	8·8	83	3·2	13	7.9
				6	8·8			13	7·9		
		Easting		191	7·7	Northing		69	7·3		

Now we find that as the westing and southing of the back dialling corresponds with the easting and northing of the direct dialling to the fraction of an inch, it amounts to a mathematical demonstration of the perfection of the underground survey. It now only remains for us to obtain the hypothenuse and angle opposite the base of the two given sides of the triangle formed by the easting 191 feet 7¾ inches, and northing 69 feet 7 inches, which will be found to give:—

Length (from centre of Pendarves' shaft to point over end), 203 feet 11½ inches.

Bearing, 20 degrees north of east.

FROM EASTERN END TO PENDARVES' SHAFT

No.	Angles and Lines.		Trigonometrical Results.			
Drafts	Bearings.	Lengths	East.	West.	North.	South.
		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
1	8¼° S. of E.	26 10	8 11·6	. .	. .	26 6·5
2	11 S. of W.	15 0	. .	14 8·7	. .	2 10·3
3	4¾ S. of W.	19 6	. .	19 5·2	. .	1 7 4
4	13¼ N. of W.	20 0	. .	19 5·6	4 7·0	. .
5	9½ N. of W.	52 3	. .	51 6·5	8 7·5	. .
6	1¼ S. of W.	44 0	. .	43 11·9	. .	0 11·5
7	7 S. of W.	26 0	. .	25 9·7	. .	3 2·0
8	9¾ S. of W.	22 8	. .	22 4·1	. .	3 10·1
9	2¼ E. of S.	43 10	1 8·6	. .	. .	43 9·6
			5 8·2	197 3·7 5 8·2	13 25	83 9·4 13 2·5
			Westing	191 7·5	Southing	69 6·9

N.B.—After this length and bearing has been applied at the surface, and the point fixed for the centre of the new shaft, an infallible and desirable proof that this last and important work has been done correctly may be obtained by availing ourselves of the ready means placed within our reach by the cardinal points or sides of the great triangle. Thus, by measuring off from the centre of Pendarves' shaft 191 feet 7¾ inches due east, and then from the end of that line 69 feet 7 inches due north, the end will fall exactly on the point fixed at the end of the line 203 feet 11¼ inches on the bearing of 20 degrees north of east, if the whole has been done correctly.

PLANS AND SECTIONS OF MINES.

Persons who have not had practical experience in mining often acknowledge that they find great difficulty in comprehending the plans and sections of a mine, or of having a true idea of the workings from an inspection of the drawings. This obscurity may be occasioned from an imperfection in the plans; for if they have been executed under a good *system*, it can hardly fail to exhibit clearly every part of the workings, and, indeed, if the diagrams have not been executed perfectly, and according to rule and order, even miners themselves cannot comprehend them. It requires four distinct mathematical or geometrical drawings to represent a mine, which we will briefly notice under each head; and we may observe, as we pass on, that the common cause of people in general not understanding the plans is because they expect to know too much from one single drawing. Every separate plan exhibits both a true and false view of some parts of the mine; and the knowledge necessary for the observer is, what parts of the workings it is that each drawing furnishes a true delineation of.

With this introduction we proceed to state that the set of drawings may be described thus:—

1. Ground plan.
2. Horizontal or working plan.
3. Longitudinal section.
4. Transverse section.

And taking them in the order in which they have been placed, we begin with—

(1.) THE GROUND PLAN.

This is, in the main, a general survey of the whole set, or land granted to the adventurers for the purpose of mining. This plan may be on a scale of three or four chains to an inch; and every landowner's bounds should be distinctly marked on this map.

All the lodes are laid down with their true position and course on this plan, as far as they can be ascertained; and we may remark, that this survey should be made at the outset or plant of a mine, and before any thing has been determined as to the position of an engine shaft, or any other important work, so that the manager may have the benefit of this map, with the lodes, cross courses, and every necessary thing faithfully delineated thereon, to assist his judgment in forming the most judicious arrangement for future operations. For want of this precaution, how often is it that shafts have been sunk in improper places, to the endless disadvantage to the company; and sometimes they have been abandoned and new shafts sunk, at a fearful loss of time and money! In fact, we believe there are but few mines where the conductors have not had cause to regret, ultimately, that they had not taken another position for sinking the principal shafts, and which might have been known, at the outset, if the necessary steps had been pursued.

On this map it should be particularly pointed out if there is any intervening ground on the course of the lodes, that has not been legally granted, so that proper applications may be made in due time, and not leave it until the workings have been commenced, and good discoveries made, and then this landowner, taking advantage of the neglect or oversight, demanding an unreasonable premium and dues for his land, or prohibiting us from driving an inch under it, on pain of knocking us to pieces with the powerful arm of the law.

(2.) HORIZONTAL OR WORKING PLAN.

This is the miner's plan, his chart, his guide, his right hand. Whoever attempts to conduct the operations of a mine without a perfect working plan, is unfit for his office. The very circumstance of his supposing himself capable of doing so, is a certain proof of his ignorance.

This plan gives, what surveyors call, "a bird's-eye view" of the mine; or let us suppose that the ground was transparent, and

by walking over every part at the surface we could look down and distinctly see all the workings.

A person who never saw a mine will understand from this view that he could distinguish the course of the levels in all their turns and windings, and, as respects all the "horizontal" drivings, he would have a *true* view of them; but these drivings are the *only* thing that he would obtain a true view of in this plan.

Keeping his position in view, he hardly requires to be told, that he can only see the brace or mouth or base of all the vertical or downright shafts, even if they were 200 fathoms deep.

As for the diagonal shafts or winzes (which are small ventilating shafts sunk on the declination of the lode from level to level), he would only see the "underlay" of them, or the distance that they diverge from a perpendicular line. As lodes, almost if not altogether without an exception, have a dip or declination, called by miners "underlay," it follows that the levels are generally removed away from the vertical line, and not concealed one by another, although this is sometimes partially the case when there is a reverse or change of underlay. In addressing myself to the miner, in reply to his question or inquiry respecting the best method of constructing and keeping up a working plan, I will endeavor to explain the system I always adopt, and which I believe is the best, at least I have found it so, after thirty years' experience. Let the scale be five fathoms to an inch. Before you begin to lay down any part of the workings, draw faint lines throughout the whole length and breadth of your sheet of drawing paper at right angles, forming two-inch squares; these lines will be your cardinal points. If your lode bears east and west, the longest way of the paper will of course be appropriated for that bearing. These lines are always to remain; and as they are to be single, and fine, and the course of your levels drawn with double lines, they will not in the least confuse, especially as your levels must be distinctly and variously colored between the double lines (which represent the breadth of the level), so that every level, with all its drifts and connections, may be distinguished in a moment or two, however numerous or complicated your levels and drivings may be. One grand advantage of these cardinal cross lines is, that every intersection forms a proper and suitable point for laying on the centre of the double-limb protractor, or any other, on all occasions, so that in keeping up the plan or laying down any additional drafts, there is always a point close at hand for the protractor, without the inconvenience and risk of bringing on a north and south line, for the purpose, from a distant part of the paper. Another convenience of these lines is, that the bearing of the lode, or any part of it, may, by their help, be obtained in a few seconds; for instance, as every side of one of the squares gives 10 fathoms, when a level has been laid down, we can, by inspection, see very nearly (and by

the application of a scale exactly) what it has diverged to the right or left from the main course, and if we find it to be (say) 125 fathoms east, and 19½ fathoms north, the tables will tell us that the bearing is 8° 50′ north of east; and, by the same means, we may always check or prove the truth of the plan or the construction by trigonometrical computation, and which should always be done before the plan is relied on, or pronounced perfect.

This plan, proved and well kept up, becomes invaluable to the mine agent. Does he want to sink a winze in one level and rise against it in another? Every thing he can wish for is before his eyes. The two corresponding points for the sink and rise, the amount of underlay, the bearing, the length of the winze and its vertical depth, are all embodied in the plan. Has the lode split, and have the workmen driven on the wrong branch? look at the plan, and compare notes with the general bearings, and the course to be adopted will be apparent. I have known a case where the plan betokened that a misdriving had taken place in a level, but the agent persisted that the driving was right in spite of the plan; however the manager, having more confidence in *computation* than in *conceit*, was convinced by the indications of the plan that they were gone off the main branch, and ordered them immediately to "turn house," or cut north at right angles: this was done, and in driving two fathoms, the main lode was discovered with a large and rich course of copper ore.

(3.) LONGITUDINAL SECTION.

This drawing supposes that a section of the ground has been cut away, and that a side view of the mine is exposed. If it is an east and west run, the observer is placed at the south of the mine, and taking a panoramic north view of all the excavations.

In this position he will have a perfect sight of all the vertical shafts, and a general view of the stopes, or ore ground broken away between the levels, also the dip of the courses of ore may be portrayed and distinguished, and the surface line of the country, with a perspective view of the buildings and machinery, may be seen or exhibited fairly by this section. But the levels, diagonal shafts, cross-cuts, and winzes, will have a false or imperfect appearance here. For instance, the levels will *appear* to be perfectly straight, however serpentine or crooked their course may be. The diagonal shafts and winzes will appear to be perpendicular, because their dip is in the line of the inspector's eye; and as an *end* view will be taken of the north and south cross-cuts, the extent of these drivings will not be seen.

The only real benefit of this section to the miner is, that it may be so contrived as to show the dip, or inclination, or declination, of the bunches or courses of ore, and this circumstance he may turn greatly to his advantage in working the mine. For

example, suppose in driving the 50 fathom level, going east, we cut into a course of ore, and it lasted 25 fathoms in length; let these two points of the "coming in" and "going out" of the course of ore be correctly marked in this 50 fathom level of this section.

In the 60 fathom level, or next level below, the same course of ore was cut 4 fathoms farther west than it was in the 50, and the course of ore at this level proved to be 28 fathoms long. Let these points also be marked on the section, and as there is a general regularity in the dip of ores, the agent is now in possession of a clue, whereby he may form a reasonable judgment at what place the course of ore will come in at the 70 fathom level, or levels still deeper, and also at what point it will fail in driving east, hence he will be better qualified for setting tribute with the help of this section than if he had no such guide. The longitudinal sketches that are usually shown in mines, with a pell-mell blotch of the stopes, and, as we have shown, the false view of the levels, diagonals, and winzes, are useless to the miner, and deceptive to the stranger.

(4.) TRANSVERSE SECTION.

Here the view is taken at one end of the workings. Suppose again the drivings to be east and west, and the dip of the lode northerly, the observer is placed at the west end, with his face easterly. Now, for the first time, he will have a fair view of the declination of the shafts and winzes that have been sunk on the course of the lode, and thereby he will see all the dip and variations of the lode from the surface to the bottom of the mine. Here he will see the northing and southing made by the cross-cuts, and if a vertical shaft is in sinking to take the lode at a certain depth, the point of intersection will be apparent to his view. Respecting the levels driven on the course of the lode, he will only see their western end. If there has been no diagonal shaft, but the mine has been worked by a downright sump or engine-shaft, this section will exhibit a regular and correct view of all the drifts or cross-cuts, from the shaft to the lode, and from this data, or the extreme ends of the cross-cuts, the declination of the lode will be conspicuous. The transverse view of the surface line will finish all that can be fairly seen by this drawing.

OBSERVATIONS.

After such a detail we think there will be no occasion for "summing up," or repeating to the inquisitive stranger, or adventurer, what may be seen, and what may not be seen, on each and every drawing. To the practical man, or with him, we may converse of the best and readiest means of making these drawings. Let us suppose the horizontal or

working plan to be drawn and executed, and proved in a correct and masterly manner, and all the vertical shafts truly *dropped* or measured. We are then in possession of every thing necessary for drawing the two sections without going out of the office; for by parallels, or a drawing board and slides, all the shafts, winzes, &c., may be transferred from the plan to the paper prepared for the sections, with despatch and accuracy. True, we may have recourse to the dialling book for the position, length, height, and depth of the stopes and sinks; and if a perspective drawing of that part of the set where the buildings are placed should be required, a sketch must be made for that purpose.

To the learner we would observe, that, if he is about to survey a mine and draw a working plan, let him lay down his shallow adit, or the upper levels, first, and the others in succession; because, wherever any *crossings* take place, or one level or draft passes immediately under another, the upper level must be entire or unbroken, and the under level will not be shown, as a matter of course, being necessarily obscured or concealed by that part of the workings that passes immediately above it. One method of proving his work as he proceeds is as follows:—Suppose he has surveyed the adit level, and there are four winzes communicating with the 10 fathom level, and he has taken the bearing, and depression, and length of those winzes, and plotted or laid down this level and the true base of those winzes on his working plan. He then proceeds to survey the 10 fathom level, making good every thing as he proceeds; and of course when he arrives at the foot of those winzes which he surveyed in the adit, he minutely enters in his dialling book the mark at their foot, where he took his diagonal observation and measurement. Then in laying down his 10 fathom level, if all his work has been well done, the points in those winzes will exactly correspond with his survey in the 10 fathom level and on the plan, and this desirable check he may and should pursue throughout the whole survey. It is too common in these cases, in order to avoid the time and labor in surveying the winzes to "let them take their chance," by merely entering their "brace" in one level and "foot" in another, and let the truth of their respective bearings and underlay depend on the horizontal survey of the levels. This practice is reprehensible, and should never be tolerated. But, with all this precaution, we advise, by all means, that every part of the plan be proved by trigonometrical computation, and the surveys by fore and back diallings. Let us suppose we have surveyed a level by double diallings. How shall we ascertain if there is a perfect correspondence? We have introduced a problem on this subject, and it is plain that the final two sums of the traverse will demonstrate either the agreement or the difference. This being done, and the underground work proved correct, we proceed to construct or draw the level on the plan, and it is most desirable that

we should know if this part of the work has been well executed; as we have computed the workings, we are furnished with a ready and certain test. Suppose we found, by computation, that the level gave, from beginning to end, 184 fathoms 3 feet of southing, and 34 fathoms 4 feet of westing. Now, apply these numbers to the plan, we shall, by the convenient help of the cardinal lines and instruments, presently prove if the latitude and longitude between the start and terminus of the level on the plan make good these lines. Lastly, I would recommend that the instruments for drawing and keeping up the working plan should be a 6 or 7 inch circular protractor, on the best principle, with double limb and vernier scale for reading off the angle, so that there may be no *guessing*, or judging by the eye, merely, for the fractional part of the degree; also, a parallel ruler of the best kind. I prefer those rulers that travel on rollers, both for expedition and accuracy, but I admit it requires some practice to use them well. There is an advantage in those rulers, in that they have an ivory edge and a graduated scale, so that the lengths may be pointed off at the same time that the line is drawn, without using a compass or dividers; and these two instruments are all that are required for the drawing department. The parallel ruler should be a foot long, divided into thirty feet to an inch; so that any line within the extent of 360 feet can be pointed off at once.

THE PRACTICAL MINER'S GUIDE.—PART III.

INTRODUCTION.

THE qualifications necessary to constitute an accomplished miner are more numerous and difficult of attainment than is generally imagined, even by persons deeply interested in mining affairs; and although it may not be expected that every one who fills a mining situation should be an adept in all the various branches of the art, yet it is certainly highly desirable that agents, who have the management of large adventures, should possess a general knowledge of every thing connected with the profession of a miner.

The following miscellaneous subjects are essential to the practical miner, and require no comment to set forth their utility; they may also be found useful and interesting to persons not immediately engaged in mining pursuits.

The first article consists in a description of the art of assaying silver; and as this has hitherto been a secret in the possession of but few persons, it is expected that it will form an acceptable part of the work, especially as it will come abroad at a time, when foreign mining speculations (where the seat of action is principally among the precious metals) abound beyond all precedent.

The next part of the work contains a plain statement of the method of assaying copper, including the established process of

one of the most experienced and respectable copper-assayers in the county of Cornwall.—Rules for assaying lead and tin follow in succession, and this part of the treatise concluded with a description of the manner of extracting silver from copper ore, or of discovering the quantity of silver it contains; and probably this article also may be productive of beneficial effects to the mining interest, as there is great reason to believe that a considerable proportion of silver is contained in the ores produced from many of our copper mines. The method is very simple, and the trial may be quickly and satisfactorily made.

The subsequent part of the work is described in the table of contents.

ASSAY OF SILVER ORE.

Sample—1 ounce avoirdupois, pulverized and sifted through a fine hair sieve, then well mixed in the scoop with the following flux, viz.:

Red lead* - - -	2 oz.
Red tartar - - -	5 dwts.
Nitre - - - -	9 dwts.
Borax - - - -	4 dwts.
Lime - - - -	¼ oz.
Salt - - - -	2 oz.
Fluor spar (bruised) -	¼ oz.

Smelt the ore in a wrought-iron crucible; if this cannot be conveniently procured, and a stone pot used, add 1 ounce of iron. The sample will melt in a good heat in about 12 minutes, if the ore is tolerably free from sulphur and iron, otherwise it will require more time.

When the sample has become quite fluid, take it out and pour it in a mould prepared to receive it, having been anointed on the inside with grease or oil; the process of taking out and pouring the sample must be done quickly, otherwise a degree of chill will take place, so that the metal will not run freely out of the crucible, and the assay will in consequence be imperfect.

If the operation has been properly managed, the lump will separate clean from the slag or dross by a slight blow; but if the metal and dross stick together, the assay is impure:—it is probable a little more nitre would remedy this defect.

Should the lump when broken display the metal disseminated throughout and uncombined among the slag, it is a proof the sample was not sufficiently flowed, or not kept time enough in the furnace.

If the heat is too strong, or the sample left too long time in the fire, it will set, or become dry and callous, and this change

* An ounce of red lead generally contains about 1-32d part of a grain of silver, or nearly 3 ounces of silver in a ton. Derbyshire lead ore is preferred, by some assayers, to red lead.

The proportion of silver contained in the flux must first be known, and the regular deduction made from the produce, in order to obtain a true assay.

will take place to all appearance quite suddenly. Either the former circumstance of too low a heat, or this of too high, renders the assay irremediable.

Should the sample appear stubborn and refuse to melt in a brisk heat, add more nitre.

TESTING OR REFINING PROCESS.

The test or cupel should be composed of four-fifths bone ashes to one-fifth fern ashes, damped and well beat into an iron ring 2¼ inches deep, and 6 inches in circumference.

The test should be put in the fire an hour or more before the refining process is begun, otherwise the silver will be apt to be agitated by the unsettled test, spring over, and consequently the assay be destroyed.

Should the assay set in refining before it has become pure, throw in about half an ounce of potter's lead.*

If the fire is permitted to get low, or too much air admitted into the furnace, the assay will be apt to turn to litharge; whenever this happens, increase the fire by putting in a few pieces of sea-coal instead of coke, at the same time sprinkle a little coal-dust on the test.

When the assay is thoroughly pure or fine it will assume a globular shape, set, or become fixed, and in a few moments will throw up sprouts or branches from the top. Take out the test, weigh the prillion, find in the table the produce or value per ton, and the work will be complete.

ASSAY OF COPPER ORE.

Sample—400 grains pounded well in a mortar and sifted through a fine hair sieve, put in an earthen crucible, and frequently stirred while in the furnace with an iron rod or paddle. The sulphur will be seen to go off in white fumes; the process must be continued until this evaporation ceases, or nearly so, which will generally occupy from one to two hours. Great attention must be paid during this operation in order that a standard regal may be obtained, which being done, there will be no danger of producing a true assay. The ore during the process, must be kept in a free, sandy state, which will be effected by stirring, and constant regulation of the degree of heat. If the ore becomes moist and begins to stick or adhere to the crucible, it must be immediately taken out of the fire and stirred a short time till this effect has ceased, and then returned. When it has become tolerably free of sulphur, it may be discovered by the

* The fire should be gradually increased toward the close of the process. A muffle or arched cover to the test would prevent the air from taking an unfavorable effect on the assay, while the furnace is opened for the purpose of increasing the fire, by adding coal, wood, or coke.

evaporation having nearly ceased.* This being observed, take it out of the fire, and let it gradually cool in the crucible; and if, when cold, the upper part appears red or brown, and the under part black, it is a proof of its having been well calcined.

This being done, add standard flux; viz.

Borax*	- - -	5 dwts.
Lime	- - - -	1¼ ladle.†
Fluor spar (pulverized)	-	1 ladle.

Mix these together with the calcined ore in the crucible, and cover the whole with salt,—let it melt well, and a regal will be produced.

MARKS AND REMARKS.

A good or standard regal is brown, and full of cracks or fissures, and of a spherical shape. Should it come out flat, it is a mark of its not having been well calcined, and may be thrown back again with a small quantity of nitrate.

Should a regal come out too low or coarse, (having, when broken, a cinder-like, or cellular appearance,) throw it back with additional nitre: if too high or fine, (having, when broken, a metallic appearance) return it to the crucible with a ladle of sulphur; in either case let it work well together a short time, and in all probability a standard regal will be produced.

A regal may be considered good, which will produce from 8 to 12 in 20, and this quality is easily known by inspection; but if less than 8, or above 12, it would be better to reject it, and begin the progress again with a new sample.

Gray, black, and green ores, require a proportion of sulphur, in order to throw them back, as they contain too little of this mineral in their composition to produce a good assay.

Should a regal be too fine, put less nitre with it in refining; and therefore the coarser it is, the more nitre will be required.

FINING PROCESS.

Pound or pulverize the regal, put it in an earthen fining pot, and re-calcine it until perfectly sweet (*i. e.* free from sulphur), which may be discovered both by the appearance and fumigation. Then add

Nitre	- -	3 dwts.	Covered or sprinkled over with salt.
Red Tartar	-	10 ditto.	
Borax	- -	5 ditto.	
Salt	- -	2 ladles.	

This brings down the assay into coarse copper. Should it come

* It is only some very stubborn ores, containing a mixture of metals, or semi-metals, which require to be so effectually roasted or calcined.

† Common assaying ladle—diameter ¾ inch, depth ½ inch.

out having a transparent or horn-like appearance, add 4 dwts. of nitre and a ladle of salt, letting it work well in the fire. Should the assay come out black, plate it, and if the black flies off in flakes or scales, it is a proof of its not having been sufficiently calcined; if not, its color may be attributed to lead, or a mixture of metals; the former defect renders the assay hopeless.

Should it come out clean, put the assay in the pot without flux, and when fluid, take out the pot and shake it gently until the surface assumes an azure or blue appearance; then put

Refining flux* - - -	5 dwts.
(viz. 2 parts nitre, to 1 part white tartar)	
Salt - - - -	1 ladle.

Preparatory to pouring into the crucible, place the refining flux in the mouth or forepart of the scoop and the salt behind; throw it in with the assay and let it melt until the flux settles well down, then pour the copper into one mould, and the slag or scoria into another; return the slag into the same pot with 2 ladles of red tartar, and let it melt well down; take out the prillion and weigh it with the lump for the produce, and the work will be completed.

ASSAY OF LEAD ORE.

Sample—1 oz. avoirdupois.

FLUX.

1	common ladle	red tartar.
1	ditto.	spar.
2	ditto.	salt.
$\frac{1}{4}$	ditto.	borax.
$\frac{1}{4}$	ditto.	nitre.
$\frac{1}{2}$	ditto.	lime.

Mix the flux with the sample and put it in an iron crucible, stir it with an iron rod during the latter part of the process; in about five minutes, in a brisk heat, the sample will be down, provided the crucible was red-hot when the assay was thrown in, which should always be the case.

If the sample, to be tried, weighs four ounces, the proportionate quantity of flux must be added, agreeably with the above statement.

It may be discovered when the sample is ready, by the grating of the rod against the bottom of the crucible in stirring—it should then be immediately taken out and poured. The metal will separate clean from the slag in a good assay.

* The refining flux should go through a calcining process before it is used; it may be done by putting two parts nitre to one part white tartar in an iron mortar, to which apply a red-hot iron, and stir it therewith until the deflagration has ceased; when cold, powder and sift it.

This operation will prevent any commotion during the refining, which otherwise may be so violent as to cause some of the metal to spring out of the crucible, and thereby the assay be spoiled

To assay lead ore for discovering the quantity or proportion of silver it contains, the foregoing method must first be used, and the assay then tested precisely the same way as described for refining a silver sample, page 213. The lead will go off in vapor, and the silver remain in the test.

ASSAY OF TIN ORE.

Sample—Two ounces black tin.

FLUX.

Culm	-	½ weight of sample
Borax	-	4 dwts.

PROCESS.

If the ore contains a large proportion of iron, add more culm*; when the sample is properly down, or flowed, the surface of the assay in the crucible will be perfectly smooth and motionless; in a strong heat this will occur in about twelve minutes.

When taken out of the fire, stir it well with an iron rod before you pour it; afterwards scrape the crucible, pulverize the scrapings in a mortar, and then van or wash them on a shovel. The prillion of a standard sample will not exceed 2 in 20.

The criterion for the lump is its possessing a malleable quality, or bending to the hammer without breaking.

Grain tin may be treated in every respect as the above, except in the subsequent addition of culm, which will not be required.

METHOD OF DISCOVERING THE PROPORTION OF SILVER CONTAINED IN COPPER ORE.

Sample—One ounce.

FLUX.

1 ladle red tartar.
1 ditto nitre.
½ ditto lime.
½ ditto borax.
1 ditto fluor.
1 ditto red lead.

Well mixed with the ore and melted in a wrought iron crucible,† about eight minutes, in a brisk heat, will be sufficient; the last five minutes the assay should be incessantly stirred with an iron rod: pour the sample and cool it, then break out the lump, and test it in the usual way.

REMARKS.

Soon as the assay begins to flow, the lead, by the power of affinity, will presently attract the silver, or the silver, by the same law, will attach itself to the lead, and this being effected, it only requires the process of refining, or burning off the inferior metals, to find the produce.

* If the sample is very stubborn, add a small quantity of pulverized fluor with the culm.

† If a stone crucible be used, one ounce of iron must be added to the flux.

ART. II.—A SKETCH OF THE MINES AND COPPER REGION OF SOUTH-WESTERN VIRGINIA.—BY W. J. MARCH, M. E.

THE Copper Mining region of south-western Virginia is situated in Carroll and Floyd counties, in the ridges between the Iron or Smoky Mountains and the Blue Ridge. As little has been done towards the development of minerals in Floyd county as yet, I shall confine myself to giving a description of the Copper Leads in Carroll.

There are four parallel leads passing through the country in a north-easterly and south-westerly direction, and dipping to the south-east. One of the four is a Trap lead, containing native copper, disseminated through the rock. As little or no work has been done upon this lead, no estimate or opinion of its value can be given. The other three are gossan or iron ore leads. Only one of the three has been developed to any extent, namely, the northern or Great Iron Lead. This lead, besides being the most extensive and accessible, is noted for the superior quality and great abundance of its ores, at inconsiderable depths. It has been developed to the depth of the black ores for over thirty miles along its course, scarcely a mile intervening between shafts, and adits, throughout the whole line. Taking the whole of this lead throughout, there is scarcely any perceptible difference in its external appearance, to the surface indications of the celebrated Ducktown mines in Tennessee; the chief characteristics being an extensive outcropping of light, porous, brown iron ore. At points along the lead this iron ore, or "gossan," as it is termed, will be quartzose, again compact and heavy, again schistose; the t o latter being considered the most indifferent indications on the lead—not so much on account of scarcity of ores as quality. The porous, high-colored, light varieties of gossan and the quartzose gossan, invariably giving ores of high percentage; while the compact, dark-colored, heavy schistose gozens usually give ores of low percentage.

The principal ores produced in Carroll county (unlike Ducktown) are the decomposed and decomposing sulphurets. The gray and black sulphurets are very common; occasionally a pocket of black or red oxide is found; but they are never extensive, though always of high percentage. The blue, black, and steel-grained sulphurets, as found plentifully in Carroll, re always of high percentage; while the friable decomposing gray ores are usually of low percentage.

Other ores, such as blue and green silicate, green carbonate, and malachites, in beautiful crystallized specimens; also the native copper in arborescent and stalactic forms, are found in the "vugs" and crevices in the gossan.

The position of the ores are in the following order:—First, the gossan from the surface down, from twenty to forty feet at a

dip, usually, of 45°; then follows pockets of oxides, and carbonates, &c., in "vugs" and holes in the gossan. Next is the lode from one to ten feet thick, and from ten to one hundred wide; commonly lying nearly horizontal. The upper or top portions of the lode contain invariably ores of high percentage; the middle and lower divisions being usually (but not always) poor ores, at least what are considered poor ores in this country; owing to the cost of transportation to market. All ores under 11 per cent. are retained at the mines, while all over that grade are shipped off.

Beneath the black ore lies the arsenical or mundic rock (as it is named) to an unknown depth; but as it seldom contains less than 2 per cent. yellow sulphuret of copper at the commencement, and improves rapidly in quality in depth as far as yet explored, (some four feet,) it is thought by nearly all to be of inconsiderable thickness. But as the black ores are plentiful, and the cost of penetrating the mundic rock very heavy, all the present holders of property in Carroll decline going any deeper until more capital has been brought to bear upon it.

You will observe that in this hurriedly written sketch I have omitted to say much about the geological features of this regio the remarkable resemblance it bears to the Ducktown mines; the geological features of which, nearly all interested in mining industry are acquainted with, has prevented me from doing so. As for the theory of the deposition of the black ores, there are several; but I think the majority are in favor of the one advanced by Prof. Lieber, of Alabama.* The topographical features of Carroll also bear some resemblance to Ducktown. The mountains which in Ashe county, North Carolina, and Grayson county in Virginia, are high and rugged, are in Carroll county broken down into numerous parallel ridges of inconsiderable elevation; which are cut across at numerous points by large streams of water, which not only gives the miner great advantages, but gives the county more first-class water privileges than any other three counties in the State.

The usual timber growth of south-western Virginia is plentiful and heavy in Carroll county; the white oak being the commonest.

The climate and soil, all who have heard of this country are favorably acquainted with; therefore nothing need be said under that head.

Having now given you an idea of this region, I will give a few details in relation to the working of the mines, that may not be uninteresting.

Owing to the numerous streams cutting across, as before noticed, the miner is at no loss to find a place to drive in a level

* See Mining Magazine, vol. vii., November, No. 5, pp. 367.

to his ore, without encountering either of the walling rocks; therefore natural drainings to the depth of one hundred feet can be had at almost any point on the lead at short intervals; and in three or four places, a tunnel driven from the lowest water level for four hundred feet, would attain a vertical depth of from six hundred to one thousand feet! But this is an extreme, the general average being eighty to two hundred feet.

As I have above remarked, the cost of transportation, and present prices of ore, prevents all ores under 11 per cent. from being sent to market; therefore no more poor ore is cut down in the mine than is absolutely necessary for working room. The top portion of the lode being always the best, it is first stripped of its covering gossan, then carefully cut down, until the miner finds that it is getting below the standard; he then sends it out, and cuts down as much poor ore as the size of his tunnel requires.

The miner has two methods of judging of the quality of the ores he is working upon. The first is by "striping," or glancing the face of the ore with a pick, when the quality of the ore is known by the depth of color, and brilliancy of the stripe made. The best quality ores, or 35 per cent. and upwards, gives a stripe exactly like polished brass, but it soon tarnishes, and becomes dark blue. The ores that are too soft and friable to stripe, the miner judges by the second method. He takes some of the ore, and with the pole of his pick pounds it into paste, then, after mixing some of the paste with a little spittle to dilute it further, he puts it on his fore finger and draws it through the flame of his candle; the depth of the green color of the flame then given tells him its richness in copper.

The ores of the first quality sent out are thrown upon the floor of an ore shed, where they are turned over; and any poor ore that has accidentally got into it, is picked out. It is then bucked to about the size of a walnut, and when tolerably dry, well mixed and sampled, is boxed up and sent off to market. All the poor ores, or "seconds," (as they are termed,) that come out, are thrown in a heap to themselves, and no further notice taken of them—the owner hoping that some day he may find a market for them, by some cheap process of reduction, or a smelting establishment erected in the country.

All who are familiar with copper mines are aware that the great bulk of the ores seldom exceed 8 per cent., particularly sulphurets near the surface. Is it not therefore surprising that in the absence of a regular furnace, or any other means of bringing poor ores up to the required standard, that the mines can support themselves? yet they do, and even make a fair profit.

Though there are but six mines that have gone into steady operation and shipped ore, yet the number of tons sent away in the short space of two years is almost beyond belief.

It is a matter of surprise with many why such a rich and extensive mineral region has not more than six mines in operation. Such questions are easily answered, if put to those who know. Nearly the whole mineral region is held by lease or purchase, by some four or five companies of individuals, mostly from Tennessee. Two of the companies have all their available means invested in purchased property, and are contenting themselves with opening to the ore at a few points, with a view of selling, and ultimately working one with the capital procured from the sale of the others.

The other companies hold nearly all their property by leases, which they are obliged to open in a stated time to secure the perpetuity of the leases. They are all working one or more mines with profit, and opening others. It is therefore evident, that while such an extensive scope of mining ground is held by a few individuals, who cannot spare much of their capital from their separate pursuits, that the development of the mineral resources of Virginia must progress slow.

This country, therefore, at present offers inducements for the safe investment of capital, that are seldom, if ever, equalled.

Were a regular smelting company to be established here similar to the Eureka Smelting Company in Tennessee, thereby making a market here for all ores under standard, the supply could be made to exceed any possible demand for many years to come.

Smelting in any country where ores and fuel are plentiful, is always profitable. Both may be said to be inexhaustible in Carroll county, Virginia.

Art. III.—SOUTH-WESTERN BRANCH OF THE PACIFIC RAILROAD.

By Prof. G. C. Swallow, State Geologist of Missouri.

Wm. M. McPherson, Esq. President of the Pacific Railroad Company:

In conformity to the law requiring me to make Geological Surveys along the lines of all the railroads aided by the State, I have surveyed that part of the south-western branch extending from Lebanon, in La Clede county, to the State line in Newton. In this survey we have extended our examination over the territory comprised in Newton, Lawrence, Green, Webster, and La Clede counties, the southern parts of Jasper, Dallas, and Camden, and the northern portious of McDonald, Barry, Stone, and Taney. This territory is about 150 miles long and 30 miles wide, giving an area of 4,500 square miles, or 2,880,000 acres. Of this the Pacific Railroad Company owns about 650,000 acres.

In accordance with your request, I hasten to state some of the

most important facts developed by this survey, especially those which may be stated with certainty before the examinations of the Laboratory are made.

It has been our object, in making this survey, to examine into all the available resources of this part of the State, and especially those designed to furnish a people with sustenance and wealth, and provide a surplus for trade and exportation; as a dense and wealthy population, and a surplus of productions, are the real elements of railroad profits.

A more detailed report will be submitted when the labors of the Laboratory have more fully developed the value of the soils and minerals, collected during the survey.

PRELIMINARY REPORT.

Topography.—That portion of the State, over which the south-western Branch of the Pacific Railroad passes, in its course from Lebanon, in La Clede county to the State line in Newton, is a high undulating table land, rather than a part of the Ozark mountains, as it is usually represented on the maps of the country. The elevation of the highest point of this part of the line, near Marshfield, in Webster county, is 1092 feet above the St. Louis Register, while the lowest point at the State line in Newton county, is 440 feet above the St. Louis Register. Near Lebanon, in La Clede county, the elevation is 1025 above the St. Louis Register; near the eastern boundary of Green it is 1030; and about the same in the southern part of Lawrence, with but slight undulations between the points mentioned.

From this table land the country descends in every direction, by slopes so gentle, that they are indicated only by the course of the streams and the instruments of the surveyor and the engineer. On the northern slope, are the head waters of the Sac, the Pomme de Terre and the Niangua; on the west, those of the Elk, Spring River, and Shoal Creek; on the south, White River and its tributaries; and on the east, the Gasconade.

The valleys of the numerous streams which flow from this table land, are but little depressed below the general level of the country, until they have descended beyond the limits of the region surveyed: and the slopes are usually so gentle as to support vegetation and be suitable for cultivation. In places, however, the valleys are bounded by precipitous bluffs: the bluffs become higher and more abrupt the further the streams descend from this plateau. This table land presents a surface sufficiently undulating to be well drained, and yet level enough for agricultural purposes. It is divided into "oak openings," dense forests and prairie, but the soil is every where covered with a rank growth of grass and flowering herbs. The valleys sustain dense forests of trees and vines, and shrubs. Springs are abundant, and limpid streams intersect every part of the country.

It will thus be seen that one can scarcely desire a change in the topography or general arrangement of this beautiful country

Climate.—This region has an elevation of about 1,450 feet above the ocean, a rolling surface and gentle slopes of some four or five feet to the mile towards the valleys of the Osage, the Gasconade, the Arkansas, and the Neosha or Grand River, and no high mountains or arid plains to disturb the equable and agreeable temperature, which usually prevails at this altitude, under the 37th parallel of North Latitude.

There are no swamp or overflowed lands from which noxious exhalations can arise to affect any considerable portion of this country.

The climate, as these facts plainly indicate, is temperate, dry, and salubrious; the summers are long and temperate, while the winters are short and mild. No climate, in short, is better adapted to secure health and a luxurious growth of the staple products of the temperate zone.

Although this region possesses the clear, brilliant skies of the Rocky Mountains, and the high bracing air of the high western prairies, it still has a Fauna and Flora, almost tropical, and a soil approaching the best in Missouri, than which there is none better.

Water.—There is probably no part of this continent that can boast so large a number of bold, limpid springs, whose pure cold waters gush forth to beautify the land. Their numerous streams unite and form the clear waters of the Gasconade, the Niangua, Pomme de Terre, the Sac, the White, the Elk, and Spring Rivers, streams whose beauty has commanded the praise of every traveller. These springs and streams contain a great variety and abundance of excellent fish, and are driving the numerous mills and factories which supply the flour, meal and lumber of this flourishing region, and they have abundant capacity to supply all the water power necessary to propel all the mills and factories demanded by any ordinary population.

While the springs and streams, large enough to furnish excellent mill sites, are very numerous, the smaller fountains and branches are so abundant that scarcely a section is destitute of them. The pure limpid fountains and streams of the south-west, are unrivalled for their beauty and adaptation to the wants of man.

Timber.—The rich bottoms of all the streams sustain a heavy *growth* of excellent timber—burr, red, laurel, pin, and swamp white oak, black and white walnut, white and blue ash, white, red, and wahoo elm, red birch, buckeye, box elder, black cherry, hackberry, pignut, common and thick shellbark hickory, red bud, honey locust, sugar and white maple, mulberry, American plum, hazle, pappaw, sycamore, muscadine, summer and frost grapes, and several species of thorn and willow, are most abundant.

The slopes and some of the high land sustain forests of nearly

all the trees above named; while other portions of the high land have a medium growth of post, white, black, and Spanish oak, black hickory, yellow pine, sumach, hazel, and grapes. But a large portion of this region is sparsely timbered with dwarf black jack, post oak and black hickory. This stunted growth is not, however, due to the poverty of the soil, but to the effects of those annual fires which have overrun the country for many centuries. These fires have entirely destroyed some of the young trees, while they have scorched and very much retarded the growth of those sufficiently vigorous to withstand their ravages.

The timber of this region is good, and sufficiently abundant to supply all the demands of a dense population; and, besides, the spontaneous growth of the Osage orange sufficiently proves the adaptation of the soil and climate to its culture.

Soil.—Almost every acre of the river bottoms is rich and well adapted to the cultivation of corn, wheat, oats, tobacco, and the grasses; some of them would produce good hemp. The prairies are generally very fertile, and produce good crops of the above-named staples, though but few are suitable for hemp. The lands timbered with white, black and scarlet oak, and black hickory, are better than such a growth usually indicates, and will produce a good yield of corn, wheat, oats, and tobacco. A portion of that covered with a scattered and stunted growth of black jack, and post oak, and black hickory (the oak openings) is also good, but a large part of it is so filled and covered with fragments of chert (impure flint) and hornstone, as to render it unfit for ordinary cultivation; but the soil is still rich and produces excellent grass, and will give good timber when the annual fires are stopped.

As we descend the streams on either side of this table land, whether towards the Osage on the north, or the Arkansas on the south, the bluffs become higher and the declivities more precipitous, and the slopes and the ridges are more completely covered with chert and hornstone, and less adapted to cultivation.

Still, as has been shown in my former reports, the greater part of what has been considered the poorest land in this region, is wonderfully adapted to the cultivation of the grape; and the day is not far distant when it will command the highest prices for this purpose. The Fox, the Summer, the Frost, and the Muscadine grapes, grow luxuriant in all this region; and such is the vitality and hardihood of the Muscadine in this climate and soil, that it takes root amid "the thickest of the flints," and produces an abundance of its delicious clusters, in defiance of the annual fires, which are so universally destructive to the vine. There is probably no place on this continent, where the soil and the climate, and the conformation of the country, are so well adapted to the grape culture, no place where the grape grower can expect so certain and so abundant returns for his labors in the vineyard.

Geology.—The geological structure of this region under consideration is very simple, and yet very interesting. The lower carboniferous rocks underlie the superficial deposits on all these high lands from the State line in Newton to the eastern boundary of Green county. Nearly all of Newton, Lawrence and Green counties, and the southern part of Jasper and Dade, and the northern part of McDonald, Barry, and Stone, are lower carboniferous. But the valleys of the Turnback creek, in Lawrence, and the Pickerel, in Green, are cut down through the carboniferous into the Chemung. The valleys of the Sac and Pomme de Terre, cut down through the Chemung into the calciferous rocks on the north of Green, as do all the streams to the south, in the north of Taney and Stone, and the middle of Barry and McDonald, so that the calciferous sand rock becomes the prevailing formation in Taney and Stone, and the southern parts of Barry and McDonald.

The divisions of the carboniferous developed, as above stated, are Archimedes limestone in the west, and the encrinital in the east, and the ferruginous sandstone on the higher parts of the whole. This sandstone rests, sometimes on the Archimedes limestone, and at others on the encrinital.

The divisions of the Chemung are the chouteac beds, the vermicular sandstone and shales, and the lithographic limestone.

The first, second and third magnesian limestones, and the saccharoidal and second sandstones of the calciferous series were observed.

Minerals.—The mineral wealth of the region under consideration is very great, and cannot fail, when fully developed, to command the admiration of the world, and greatly increase the material wealth of our State.

Building materials are very abundant in all parts. There is an ample supply of limestones and sandstones and marbles suitable for all the purposes to which such materials are applied in domestic economy. Clays, sands, gravel and pebbles also exist in large quantities.

Iron Ore of most excellent quality exists in great quantities. The red and brown hematites are the most common; they occur in the ferruginous sandstone, and are most abundant in the west and south-west of Green county. Furnaces might be established here with great promise of success.

Zinc is also found in large quantities. Zinc blende (the black Jack of the miners) is abundant in nearly all the mines of the south-west. The carbonate and silicate of zinc also occur in several localities. Whether these ores can be separated and smelted with profit, will be better determined when we have made the analysis of them.

Copper.—The sulphuret and the carbonates of copper were observed at several localities in the mines of Taney county, in

the Granby mines at Spurgeon's Prairie, and at several localities in the western part of Green county, and in the north-eastern part of Lawrence. The most promising localities are those in Lawrence and Green, and the "Goose Diggings" in Taney.

Lead is to be the great staple of the south-west. Some years ago, I reported it one of the best lead regions of the world. All the subsequent developments have proved the accuracy of that estimate of the mineral treasures of Jasper and Newton counties. Since that time many of the old localities have been more fully developed with great success, and various new ones have been explored with results in some cases still more satisfactory.

The mines on Spring River, on Turkey Creek, and in Spurgeon's Prairie, still promise the most satisfactory returns; while at Granby, on the northern border of Oliver's Prairie, the results have been truly wonderful.

In the fall of '54, there was not a cabin on the site where Granby now stands with several thousand inhabitants, and only one shaft had been sunk into the rich mineral veins beneath it, which are now penetrated by thousands. Mining at Granby has been most successful, as is evinced by the great number of miners and merchants who have here congregated in so short a time, and so far away from the great thoroughfares of travel, and by their contentment and satisfaction with the result of their labors.

Explorations have also been very successful in showing the existence of large quantities of lead in the northern part of Taney county. There are very flattering indications of abundance of mineral in this region, and there are other localities of less importance, which will be described with those already named in our report.

In '54, there were only two blast furnaces in the south-west, now there are at least eight. It should be remembered that all *this* has been done so far from market and the means of cheap transportation, that the best lead ore at the mines is worth less than half the price it commands at the other mines of this and other States.

Population.—In 1850 this region had a population of about 30,000, which has since rapidly increased. The country is sparsely settled, with a hardy, energetic, intelligent, and thrifty yeomanry; while the towns are flourishing and rapidly filling up with a wealthy and refined population.

Public schools are every where established, and most liberally endowed with the large State school fund, and liberal grants of public lands. Every town has its private schools, established by the munificence of the citizens: many of them have very fine buildings, and are most excellent schools.

The lands of your company comprise more than a fair proportion of the good soil and mineral wealth of this region. The

town of Granby and other localities of lead, equally good, and some of the best deposits of iron, are on the lands of the south-wertern Branch of the Pacific Railroad Company. Much of the mineral land would be cheap at $1,000 per acre. The value of the mineral lands is very great, indeed almost fabulous, and can scarcely be realized until the railroad is completed, when the mineral raised will command something near its market value in St. Louis. The fine agricultural lands cover a large extent of the country, are very desirable, and will be rendered much more valuable by the completion of the road; as no country can be more desirable than this, when the communication by railroad is completed to St. Louis.

In the detailed report, now in preparation, we shall give the quantities and localities of mineral and good agricultural lands. We are also prepared to report on a large portion of the remaining part of the line, and can safely say, from surveys, already completed and now in progress, that there are vast quantities of iron and lead on the eastern portion of the line.

ART. IV.—REPORT OF A GEOLOGICAL SURVEY AND EXAMINATION UPON THE LANDS OWNED BY THE TENNESSEE AND VIRGINIA MINING COMPANY, INCLUDING THE MINES KNOWN AS THE CRANBERRY, WILD CAT, AND ANN PHIPPS. BY MONTROVILLE W. DICKERSON, M. D.

THE lands of the Tennessee and Virginia Mining Company are situated in Carroll county, Western Virginia, twenty-two miles south-east of Wytheville; and comprise upwards of ten thousand acres.

The geological formation of this section is simple, being chiefly composed of the conglomerates and slate rocks, more or less charged with the ocherous oxide and decomposing iron pyrites. The conglomerates here assume a different aspect; the grains of quartz, which forms one of its constituents, have a fine amethystic color.

It is underlaid by a fine-grained compact, hornblend and felspar, analogous to greenstone. In the midst of the talcose slate occur large veins of quartz—in many places sixteen feet in width. Copper pyrites occur abundantly, intermixed with quartz in most of the veins.

Upon the Dalton property such a vein occurs full of nests and bunches of the sulphuret of copper—in every respect resembling the Fentress and McCulloch formation, in Guilford county, North Carolina.

This immense quartz vein, containing copper ore, dips North 28° West.

Upon examining a shaft at the Dalton Mine where they had sunk some forty feet, I found an evident tendency in the vein to become more vertical in its dip. It is very desirable that the lode should have a more vertical dip, for all mining operations are much more simple on erect veins, as there is less cross-cutting required, and fewer winzes to be opened in the levels.

I examined most of the leads and openings occurring on the several parcels of land, now in possession of the company, and I have, as far as practicable, determined the course of the leads on your property to be North 45° East, and South 45° West, and its dip averaging 42° South-East from its horizontal—and its course extends throughout the boundaries of the property.

The Earley lead may be regarded as sufficiently proved for a distance of twenty miles. This lead has been uniform in its productiveness throughout the whole extent that has been worked; and its surface manipulations upon the unbroken ground in the way of prospecting, for miles, has proven the same as were presented in the sections which were wrought; and it is but reasonable to conclude that the yield will continue to be as rich as it has been.

The true character of the lead may perhaps be more fully comprehended by following the Betty Baker to the Kirkbride Mines, a distance of nine miles; at the *Betty Baker* we have the vein one hundred and fourteen feet wide, and at the *Anna Mary Mine* contracting, but improving in depth. At the *Eliza Jane*, width slightly closing, but making in depth; *Kincannon* improving in depth and ore. *Brown and Stephenson*, but slight variation in width, ores excellent, and thus continuing till you reach the *Cranberry* and *Wild Cat*, where the width of the vein as yet has not extended beyond thirty-two feet.

Thus you see at all these points, throughout the distance of nine miles, where operations have been continued, the lode has not failed in the least, nor become impoverished, but on the contrary holds its average size, and gives evidence of a long continuance.

It may not be amiss before entering upon a minute description of the openings, to give you some idea of the character of these several mineral leads. The course as ascertained by the outcrop and openings, and as laid down in the map, will not always be found to correspond exactly with the main course of the leads.

You will observe that, to some extent, they follow the course and bends of the bluffs on which they occur. Seams of white quartz interlaid with chloritic greenstone, forming small feeders, often occur, and invariably carry a rich lode of copper ore.

At the point where these feeders occur, the vein runs invariably 46° East of North, with a varying dip.

Openings have been made upon five different leads, designated upon the map as the *Earley, Dalton, Dickeson, Toncray*, and *Native*.

Other leads have been mentioned and figured on the maps, but of their existence I am not yet aware. These leads are of variable richness, but all present in themselves favorable appearances. The great Earley lead as yet stands at the head; and should it continue to preserve its present character, it will rank with the most valuable yet discovered in America.

It cannot at present be known, of course, whether the lead is equally rich throughout the whole distance of your lands, but from the different openings already made at numerous points, it has not failed to prove equally rich at all of them.

Two series of operations have been carried on in the prospecting of these mineral leads; one, by driving horizontal galleries from the sides of the hills on the course of the vein; the other by a series of cross-cuttings made at various elevations on the east flank of the mountains. The researches in the former direction have brought to view immense lodes of cupreous ore—in several instances exceeding thirty feet in width.

Having concluded the preliminary remarks on the extent and resources of these properties, I will now enter upon the more minute detail.

The point at which we commenced our examination was at the Cranberry Mine. It is situated near the waters of big and little Reed Island Creek, twenty-two miles south-east of Wytheville. The property was formerly owned by John Earley, and contains one hundred acres, and extends half a mile on the lead. As well as I can ascertain, it was the second point at which copper ore was cut in this country by regular mining.

Two shafts had been sunk on the south end of the lead, below the summit of the bluffs, which proved the lode upwards of six hundred feet. From the side of the hill a horizontal gallery was driven, on a course of 45° East of North, and extended upwards of four hundred feet, giving an average width of seventeen feet of copper ore, and no horse occurring in that extent of workings.

On the east end, the mundic rock rode entirely over a bed of gossan eight feet in thickness, making at this point an extensive bed of ore. One hundred feet from the opening streaks of flucan occurred, hanging the south wall, near which an extensive deposit of red oxide of copper was found. The south wall is well defined, being composed of a talco-micaceous slate, containing now and then small patches of garnets of beautiful form and color.

Numerous small vugs occur in this gallery, many of which are filled with the finest crystalline forms of ore.

In this opening most of the ores had been stoped, and in some places filled in with deads. This system of mining is carried on in most of the openings in Western Virginia; not a foot of the best ores are allowed to remain—hence visitors see nothing, save the poor ores and deads, from which they are to form an opinion of the true character of the mines.

When the finer ores are taken out of the mines, they do not allow any of it to remain in the ore sheds; it is immediately broken, boxed and hauled to market.

Without this system is changed it is needless for capitalists to visit the localities: they had better be referred to the smelting works at once.

I have seen masses of oxide of copper, weighing upwards of a ton, and yielding sixty per cent of metallic copper, instantly broken up, instead of being placed under sheds and retained for examination. How can it be expected that opinions otherwise than unfavorable can be formed under such circumstances? I therefore strenuously recommend that a suitable place be prepared at the mines, and specimens be retained, illustrating the true character of the lode.

I examined the ore bed throughout the extent of the opening and found it composed of two distinct layers, differing essentially in their percentage of copper.

The best ore occupies the upper bed, whilst the poorest the lower bed. It varies almost in every part of the mine from twelve inches to six feet, thus giving an average depth of two feet.

This is the second instance where I have found the arsenical iron passing entirely over the ore and gossan. A similar occurrence was found at the Betty Baker, and described in my report upon that property. It extended some thirty feet—and as it advanced towards the north wall diminished, and left an extensive bed of copper ore.

The arsenical iron I find occupies the same position throughout the lead. At the south end, it lies higher and dips abruptly, while at the north wall it is much lower and dips off gradually.

If the copper ore lies shallow, the dip of the arsenical iron is nearly flat—and if the ore is deep, the reverse takes place.

The depth of the arsenical iron as yet is not known, for in no instance has it been penetrated over four feet in depth.

A shaft is now in a successful tide of operation on this property, and is destined to reach the lode at the depth of one hundred feet. This I think will settle that mooted question relative to the yellow sulphuret.

This gallery starting from the side of the hill, and so much above the level of the valley, and cutting the lode on elevated ground, precludes all possible interruption from water to mining.

No apparatus excepting a windlass and kibble, has as yet been required at any of the openings for the removal of water.

I regard the openings on the whole extent of this lead as being the driest I have met with in the United States.

The lode lies between walls of micaceous and talcose slate, belonging to the silurian epoch, which has been generally transposed and modified in its character. The rock seems much decomposed, and is easily reduced to the fragmentary state,

which renders the driving in the levels comparatively easy. There has been a much greater quantity of the red oxide of copper taken out of the *Cranberry Mine* than any other opening on the lead, and is generally found imbedded in the smut ore.

Up to the time I visited the mine, one hundred and ninety tons of copper ore had been raised and shipped for market—and upwards of twenty tons of assorted ore remained in the ore sheds, and around the openings large quantities of poor ore, that would pay well if smelting works were erected in the State at any point along the lead.

The returns from the smelting works gave the average percentage of the cupreous ores received as follows:—

First Shipment, . . .	26.70 per cent.
Second Shipment, ...	29.00 "
Third Shipment, . .	23.60 "

Thus showing the average of all the ores received by them to be 26.43 per cent. of metallic copper when smelted. The above amount has all been raised during the present year, and under more favorable circumstances, might be greatly increased.

The composition of the ore presents a mixture of the various oxides of copper with iron, manganese, lead, and some silver. The working of the first-named oxides will give an average percentage of .25 of metal. So far there is found no diminution in the supply of ore in this mine, and the quality is found to continue as good as at any former period.

The next property at which we made our underground examinations was at that known as the Wild Cat. This adjoins the Cranberry property on the west, and is situated on the waters of Babbit's Creek, a tributary of the little Reed Island Creek, seventeen miles from Mack's Meadows, at which point the Tennessee and Virginia Railroad is reached—the intermediate distance being connected by a well made turnpike.

This property was formerly owned by Noah Shockley, and contains three hundred and fifty acres, and extends a half mile on the Earley and a half mile on the Dalton lead, as delineated on the map.

Mining operations were commenced at this point about the middle of February, 1855, with a force not exceeding at any time eight men. An open cut was commenced a short distance from the branch, and extended fifty yards to the foot of the hill, at which point it is driven in some fifteen feet. The course of the vein is here North 40° East. Throughout the whole extent of this open cut, and as far as it is driven into the hill, a well-defined copper lode has been exposed. The hill from this point is about one hundred and seventy-four feet high, and composed of the same talco-micaceous rock filled with small patches of garnet.

In the valley the veins dip more perpendicularly and increase

in the deposit of ore. This has been ascertained by several prospecting shafts which have been sunk in the valley, and which have exposed good ore at every point where they have cut for it. The return of sales from the smelting works also shows the abundance of ore yielded from this locality—and up to this time ninety tons of copper ore have been packed and sent off, and at least twenty tons more remain under cover of sheds. The returns from the former shipments gave an average of 23.75 per cent. of metal. As the hill has been penetrated, the quantity or deposit of ore has been found to increase in thickness—and at the end of the opened galleries large quantities of the smut ore have been taken out by the shovel alone.

The essential geological differences in this mine from those which have been described is so trifling, that a minute description would be little more than a repetition of the former localities, except perhaps, that here the north wall is well defined and almost completely filled with the small garnets. The ore is also soft, except the red oxide, and may be readily marked out by the pick and gad—no blasting being required except in the arsenical iron deposits.

The next important openings that occur on this lead are about a quarter of a mile distant, and is known as the *Ann Phipps Mine.* This property contains one hundred and forty acres, and was formerly owned by John Shockley, and extends, as will be seen by reference to the map, one mile on the Earley lead.

The first workings at this locality was commenced about the twenty-fifth day of March, 1855, and since that time the number of hands employed has not exceeded ten miners. Seventy tons of marketable ore has already been shipped off, while the quantity that is still upon the ground is not less than twenty-five tons.

The return average of these shipments, as given by the smelting works, is 29 per cent. of metallic copper, which is much above the yield of the ordinary yellow sulphurets of the southern terminus of this mineral belt.

When I visited this locality the lode had assumed a decidedly improving character, and the workmen were then throwing out masses of the red oxide, weighing upwards of one ton, which yielded by analysis 67 per cent. of metallic copper.

So far, the lode has been proven by two shafts only, and in no instance have they sunk to a greater depth than twenty feet. The bodies of ore exposed in the drifts, which have been driven under the hill some forty feet, give evidence of a deposit that eventually will become a source of great profit to the owners.

The walls here are smooth and well defined, and have the same general character and composition as the talcose slates before mentioned. The vein at this point, I ascertained to follow nearly the course of the bluffs, which have a strike of about 35°

in a north-eastern and south-western direction. The dip taken at the best exposure shows an inclination of 40° south-east, with an evident tendency to increase the angle in its descent, thus showing a great analogy, both in the geological character and relative position, with those of the Ducktown mines.

The remarkable character of this vein is its productiveness; and from the appearances presented, seems to contain inexhaustible quantities of copper ore. In the open cut, which has been driven into the bluff upwards of forty feet, the lode is fifteen feet in width, and carries with it, independently of the gray and red oxide, a fine bed of copper smut.

The remaining openings and prospecting shafts that I examined upon the lands of the company may be stated as follows:

On the Francis Limeberry property six shafts have been sunk on three distinct leads, viz.: Earley lead, Dalton lead, and the Dickeson lead, as shown in the accompanying map, and which have exposed veins upwards of thirty feet in thickness, and yielding valuable deposits of black, gray, and red oxides of copper.

On the Jerry Limberry property a shaft of twenty feet in depth has been sunk on the Earley lead, penetrating into a rich bed of the gray oxide of copper.

On the Martin Wilkerson property two shafts, twenty-five feet deep, have been sunk on the Earley lead, cutting a deposit of gray ore fifteen feet in width; from this an adit level has been driven one hundred and fifty feet in length, and is sufficient to relieve the workings at this depth from water. From these shafts fifty tons of good ore have been boxed and sent to market.

On the L. D. Blair property one shaft and one gallery has been made, one hundred feet in length, cutting considerable bodies of ore, about ten tons of which have been raised and placed under the ore sheds. These ores consist of the black, gray, and red oxides of copper, with occasional sulphurets, and have been taken from three distinct leads, viz.: the Earley, Dalton and Dickeson leads, which traverse this property.

For the last season several causes have tended to retard all operations for mining and improvements in this section of the country, viz.: inclemency of the weather, scarcity of workmen—and above all, the want of provisions; but these obstacles are all now removed by the easy access of travel—and the constant influx of population will entirely obviate the difficulty in procuring laborers hereafter.

Capital must follow as a necessary consequence where there are so many inducements for its safe and profitable investment.

The extensive operations that have been carried into effect by a few enterprising citizens of Tennessee and Virginia, have developed sufficient mineral wealth to convince the most prejudiced that this region has abundant supplies of ore, which can be easily mined, and will yield a superior percentage of metal at a very trifling cost.

Thus it will be seen from the great amount of ore that has been sent from this locality to New York, Boston, and Baltimore, that it cannot fail to establish, for quantity and quality, a character of great importance.

Whatever doubts have been expressed as to the probable failure of the ore deposits, must now be dissipated, when the extent of the leads is taken into consideration, and the points of exposure where the true character of the veins can be ascertained.

So far we must consider the extent of the mineral resources of Carroll and Floyd counties but partially ascertained; research has satisfied me that they abound in valuable deposits of copper, lead, zinc, barytes, iron, cobalt, and gold, with some other metals, all of which, by a proper geological examination or survey, may be brought to light and usefulness.

In this way many most valuable discoveries have been made of metalliferous deposits before unknown—or if known, not appreciated.

A few enterprising individuals have already turned their attention to this subject, and they have been rewarded by the discovery of extensive metalliferous veins of copper, which have called into notice others of very profitable working.

In this way several companies have already been so singularly fortunate in securing mines, that it is not only profitable, but sufficient to meet the demands while the regular preparations for more extensive workings are in progress.

The remarkable regularity of character which this mineral lead exhibits for the great distance of twenty miles—its regular course and dip, and its generally productive features, are sufficient reasons to consider it of great value—and which will undoubtedly be enhanced when they reach the yellow sulphuret, which in many openings is fast coming in the depth.

In my opinion there is not the slightest doubt as to the result, when by penetrating the stratum of arsenical iron, that of the yellow sulphuret of copper will be reached. As I have already observed, at one point in the workings, thickly disseminated patches of copper pyrites through the gangue stone, and from that fact there is every reason to believe that a very trifling distance will develop it in sufficient quantities as to become of the highest importance.

In this section of the State the country is high, healthy, and picturesque, and from the mildness of the climate, there are comparatively few impediments offered to mining operations, either in winter or summer.

I feel it my duty to state, that I can satisfy any one of a liberal mind, that these *Mines* embrace all the advantages I have enumerated, and recommend them as investments that will pay

profitable dividends for any length of time, when opened on a proper system of operation.

The time is therefore in the highest degree propitious for the commencement of such enterprises in this valuable region; and taking into consideration the numerous advantages that these leads present, I cannot doubt the result of your operations will prove highly satisfactory. I deem it of the utmost importance, that full reports be given of the wealth and productiveness of these several leads, and these too by competent and unbiased persons, as the attention of foreign heavy capitalists is now being turned towards them, but which in a measure has been retarded by the meagre reports that have been made upon them by those who have not taken the trouble to examine the formations and openings, and others whose geological knowledge was not of sufficient extent to decide when they did see them.

The companies, in a great measure, must take the blame upon themselves—for in a great majority of instances any one calling himself a geologist, and passing that way, was sure to be employed to give his opinion in the shape of a report.

I am now happy to say this system has been changed, and the apathy that has hung about them is now about to be shaken off.

Seeing the great consequences attached to a faithful account of the mineral wealth of these leads, which capitalists seem willing to aid in developing upon just representations, I have spared no pains in giving time and attention to the minute examination of these several leads and the great intrinsic value of this mineral formation.

After a careful survey of the leads for upwards of fifteen miles, I have become acquainted with evidences of the immense wealth they contain, and considering them in connection with the internal improvements already under way, my conclusions have been arrived at.

In my intercourse with the citizens of the Atlantic States, I have discovered that the idea entertained of the mineral region of Carroll and Floyd counties, of Virginia, is very vague and indefinite—therefore, not being aware that any public or private reports or documents have been prepared, I have taken the liberty to extend my remarks beyond what might be considered my legitimate province.

When all the circumstances connected with these mines are taken into view, the great regularity of the lode and softness of the rock, the great width of the veins and facility of working them, and also the immense yield of copper ore taken out of the very limited space of a few hundred feet, and the convincing certainty of extensive deposits of yellow sulphurets, present inducements for mining adventurers much beyond most, if not all, such localities hitherto worked in the United States.

In Cornwall, the copper region of England, the depth at which the ore is sought for is never less than fifty fathoms, and after crushing, washing and dressing, yields only eight per cent. of metal; while at all the mines on these properties the yield has averaged twenty-five per cent. of metallic copper.

As yet, none of the workings have penetrated at a greater depth than forty feet, and almost wholly confined to the super-stratum or loose soil, yet an almost incredible amount of ore has been raised within the present year.

The accompanying table of analyses I have made from the carefully numbered samples of ore from the different mines and openings on the property belonging to the company.

The ores have been taken as they occur in the lode, separating only the coarser foreign matter which accompanied it. The results of these analyses have varied very considerably, some of the ore was so pure as to yield sixty-seven per cent. of pure copper.

The results thus obtained, when compared with the yield of European ores, cannot but be highly satisfactory to those who hold such valuable property.

A TABLE OF ANALYSES MADE UPON SAMPLES OF ORE OBTAINED FROM THE DIFFERENT SHAFTS AND OPENINGS UPON THE PROPERTY OF THIS COMPANY.

Mines.	Copper ore.	Per centage.
Cranberry	Red Oxide	61.05
"	Black Oxide	52.10
"	Smut	26.00
"	No. 1 Poor	9.50
"	No. 2 "	5.00
"	No. 3 "	3.00
Wild Cat	Red Oxide	58.12
"	Black Oxide	50.65
"	Smut	23.60
"	No. 1 Poor	10.45
"	No. 2 "	7.55
"	No. 3 "	5.20
Ann Phipps	Red oxide	66.08
"	Black Oxide	54.20
"	Smut	24.08
"	No. 1 Poor	7.28
"	No. 2 "	5.00
"	No. 3 "	4.00

The whole giving an average of thirty-one per cent of metallic copper.

In conclusion, I must congratulate this company in having one of the best mineral properties in that section of the country; and taking into consideration that it is but partially developed, it promises to become one of the most important and extensive in the Southern States.

These remarks have been given with a sincere regard to truth, and I hope that they may be relied on as correct and impartial conclusions.

ART V.—DRAINAGE OF HARLEM RIVER. By W. B. MORLAND.

SOME five or six months ago there was considerable discussion as to the drainage of Harlem River in metropolitan papers. Amongst other correspondents was "C. I. F.," from Brooklyn, mentioning by name a large undertaking in Holland. As "knowledge is power," a few particulars on the subject may not prove without interest. The "Haarlemmer Meer," or by a synonyme, "Harlem Lake," then forms part of the great drainage district of Rheinland, with an area of 305,014 English acres; prior to 1848 this was occupied by 56,609 acres of meers and water-courses, nearly all in communication with each other, forming what is called the "boezem" or catch-water basin. The water surface being kept to the lowest level of natural sluiceage at Katwyk into the North Sea, and at Spandam and Halweg into the Y, or southern end of Zuyder Zee. Above this boezem are 75,357 acres drained into it by a natural level, and at depths 2 feet 5 inches to 4 feet below this common watershed are 170 polders or reclaimed swamp, covering an area of 135,850 acres and of 37,198 acres in 28 polders, formerly meers, but now drained with beds on the average 14 feet below the level of the "boezem." The surplus rain and infiltration water from the 175,048 acres of polder land are lifted into it by the united action of 261 large windmills with an average force of 1,500 horse power.

The drainage of the lake forming part of this, deducted 45,230 acres, reduces it to 11,379 acres, or one-fifth its former size, while the land drained is increased from 229,657 acres to 293,735 acres. Its average level is 10 inches below ordinary low-water, and 27 inches below the high water mark of the Zuyder Zee, and 57 inches below that of the N. Sea, and 7 inches above low-water of the same. The lake's bed is 14 feet below the water level of the "boezem," which gives a maximum lift of 16 to 17 feet according to the pressure of the wind, as exercising considerable influence on the water in the canals. The water pumped out, including surplus rain, &c., was estimated at 800,000,000 cubic metres or tons. The greatest quantity of monthly drainage is about 36,000,000 tons, and the annual surplus equals 54,000,000 tons to be lifted generally 15 feet high. I now propose saying a few words how these mammoth results were brought about.

Dutch engineers reported in favor of windmills and steam engines, but in '41 the late King William II., by advice of a mixed commission, decreed steam alone should be employed, and at the suggestion of Arthur Dean and Joseph Gibbs, two Englishmen, determined to erect three high pressure, expansive, and condensing engines of ordinary 350 horse power each, but capable of being worked up to 500 horse power; the consumption of fuel was limited to 2¼ lbs. per horse power per hour.

...e specimens of mechanical skill cost, with the ne-
...s, &c., some £150,000 ($750,000), whereas by
...have cost upwards of £308,000, thus saving
...000, with a further economy of works in the
...ne $200,000 more, making total advantage
...nd of $1,000,000.

...ed on an average 2,000,000 tons per
1849; the three discharged 60,000,000
...r 1 foot, and by means of this stu-
...rs time has been economized. An
...onder of engineering science would be
..., but on the maturer development of the
... up Harlem River in New York celebrity, the
... well worthy another illustration, when the intro-
... constructive details, combining statistics as to ma-
... will possibly look quite pardonable in the eyes of the
...odern "Argus," our press. Meanwhile I have in conclusion to remark that the North Hollanders being rich drained most of their lakes formed in the cutting turf for firing, &c., previous to 1646 o. s., amounting to some 99,000 acres. The Southerners had then only accomplished some 4,000 acres. From 23 acres per annum to 15,000 have been effected since that time, and they have now recovered 120,000 acres of the finest agricultural land in the two centuries, with a total of rich growth converted to profits of 124,000 acres; and collectively Holland has drained upwards of 223,000 acres. In this the Dutch have realized the fable of the "Hare and Tortoise." In 1840, erection of an engine of 30 horse power was thought a bold step; but under British guidance they have dared in the subsequent ten years to erect the largest works and most gigantic steam machinery in the world. On this side of the Atlantic we must wait for a similar desire of territorial improvement to attain the desired object of annexing Manhattan Island to Westchester county; wait, even in this age of progress and advancing civilization, until we can produce $150,000,000 worth of iron yearly, without, as now, being dependent one third on foreign supply; wait till we can work our steam power with 75 millions duty, as in Cornish engines, and not as in Pennsylvania to think 50 millions extraordinary, and wait until America more heartily encourages genius to expound and investigate the laws of nature, more especially in the Harlem River design, the rule of currents and hydraulic forces, till we sacrifice less to the molten calf—ever keeping the dollar-grinding wheel a turning—seldom thinking of others' good—aiming low instead of high in the social and moral scale as a community—cutting off from our sacred posterity those blessed privileges of that past here present;—so let us then, my brothers, now in the day of our strength be up and doing.

Art. VI.—MINERALS AND THEIR NOMENCLATURE.*

The lecture on Mineralogy treated of their nomenclature. In many cases this was beset with difficulties; it was easy to understand species, but not so facile when these were divided into classes. Several men of great knowledge had endeavored to form a systematic nomenclature; among these he could mention Shepherd and Dana, who were Americans of some considerable repute. Sometimes a professor would be teaching with a system he had adopted, while his pupils would use the common terms; others had named minerals after their chemical properties: this he did not think advisable. Many minerals thus denominated in the earlier part of the past century had been proved to have other properties, and more significant characteristics than those by which they were usually denominated. Chemistry, they were aware, was a science that was perpetually changing, and gradually advancing, so that no fixed termination could be assigned to its progress. Several minerals were named after localities, such as chalcedony from Calcedon, in upper Asia, where it was first collected by the ancients; strontia, from Strontian, in Argyleshire; towanite, from Towan, in Cornwall. Many of the minerals were named after the discoverers, and this, in many instances, was only a just tribute to the merits of the parties. Among these could be mentioned Woolastonite, Hatchetine, and Wernerite, who had described their properties. Others were denominated from their distinguishing characteristics, such as lusite, from the Greek word "lucos," a light. Some had the same synonymes in English and foreign languages, such as heavy spar, called by the Germans "schwerspath." In general, in England the favorite terminate of minerals was "lite," though correctly if ought to be "lith," from the Greek "lithos," a stone. They would see what a great difficulty there was in assigning a proper and defined nomenclature to minerals, when there was found about 800 different substances; several of these had no less than 100 varieties, and to these occasionally there were seven or eight godfathers. They all knew malachite, which was one of the carbonates of copper, and employed for ornamental purposes. By the ancients this was called chrysocolla; by the French and Germans green carbonate of copper; by an Austrian mineralogist, Mosh, who delighted in long names, it was denominated hemi-prismatic habroneme malachite; while in Cornwall it was called greens; again, barytes; this was derived from the Greek word "baros," heavy. Some of the earlier discoverers had called it terram ponderosam; the moderns, heavy spar, sulphate of barytes. The Derbyshire mines adopted the technical term "cawk;" while Mosh distinguished it by the title of pris-

* A Lecture before the School of Mines in England.

matic hal barytes. Many minerals were named after the manner in which they behaved before the blow-pipe. The physography of the mineral kingdom should be studied. It would be impossible for any one in a course of lectures to detail all the properties and distinguishing varieties of the several substances; they might be able to obtain an insight into the general characters of those which were useful to man, but when the study of minerals was considered in a purely scientific light, great research and unwearied study, combined with minute examination, were required. Water was a most important element with regard to minerals, as it entered largely into the composition of many of them. Cinnabar and petroleum were both found in a fluid state, and in the hydrates water was always present. Water gives a simple, while ice shows a double refraction. Some drawings of the crystals formed by ice would be found in Dr. Scoresby's Voyage to the Artic Regions. The flakes of snow always fell in crystals, and these were generally in the shape of a six or eight pointed star; several of them were excessively brilliant. Diagrams were then shown of the various crystalline forms assumed by the snow. Those who had travelled in the North of Germany and Russia had observed the flakes of snow as they fell were crystallized. On the windows, when a hoar frost had taken place, crystals were plainly to be noticed. Ice occurs in a variety of forms—sometimes stalactitic, at others granular, especially hail. In one of these storms, in Flintshire, he had observed hail stones of a very curious description; they were round at the base, terminating with a conical apex. Several varieties of crystals were to be noticed among the glaciers. In Sicily, where a great heat prevails, and ices are used as a refreshment, the granular snow is obtained from the mountain heights, at not an inconsiderable expense. At Etna he had seen the granular snow dug out; over it there had been a heavy layer of ashes, and on this a stream of lava of considerable thickness, emitting great heat; yet the snow had been preserved, and in Sicily especially these beds of snow were not to be slighted. Water was scarcely ever free from impurities; of the character of London water they were all cognizant. Ice always destroys the noxious elements which had formerly existed in the water.

Another important substance was carbon. The purest form of this was the diamond. The crystals of this were sometimes curvilinear. Diamonds were very rarely met with. Structure lamellar, yielding readily to cleavage, parallel to the planes of the octahedron, lustre peculiar, of a bright adamantine kind, color various—some were found black. They were considered of an impure description, but very useful for polishing and cutting hard substances: it was found in Hindostan, the Brazils, and lately, it was said, in Algeria and North Carolina. It had been reported they had likewise been discovered in Australia; and

this fact he had no reason to doubt, as Sir Thomas Mitchell, the Surveyor General of the colony, had presented a specimen to the institution. The locality which had been the longest known was India, and this country was peculiarly interesting to Englishmen. The diamond was found there in five places: the first of these was Kuddapah, and through the kindness of a friend of his, who was the collector there, he had obtained some interesting particulars of the spots where they searched for this precious gem. It was situated about 400 or 500 feet above the level of the sea. At the bottom there appeared to be a shelf; above this was the diamond bed, and over this layers of decomposed sandstone. A diagram was shown, and explained, of the several positions, the appearance being somewhat similar to a stream work. With the diamond were found several other minerals, such as epidote, jasper, and corundum, which was a rough kind of sapphire. The other localities were Punna, Golconda, Sumbhulpur, and Nandile, on the river Kistna. Tavernier had stated in his work that there was no less than 50,000 to 60,000 persons employed in the seeking of diamonds. They were said to be found sometimes in granitic eruptions. It was reported that it was met with in large quantities at Borneo. Of the mineral value of that country but comparatively little was known. They were said to be associated there with gold, platinum, and magnetic iron, the shelf being of serpentine. They were first discovered *in situ* in Brazil; the rock a sort of sandstone, which was denominated itacolumite. In 1827, a slave had first found one in the rock, but did not publish his discovery until the year 1836. The ground, however, there was worked in a most irregular manner, and were drift deposits. The gravel there was locally called "cascalho," and according to its appearance the laborers judged whether it was worth while prosecuting the search for diamonds. This they did if the stone was of a bright amethystine hue, but desisted if it was of a dull character. In the year 1823, Baron Humboldt pointed out to the Emperor of Russia the analogy between the rocks in South America and the Ural Mountains, and a search was instituted in the latter place for diamonds. Several had been found, but they were of no great value, the form of crystal they generally had being the octahedron, icositetrahedron, and the rhombic dodecahedron. Diagrams of these were shown, as well as of the tetrakis octahedron, hexakis octahedron, hexahedron and the tetrakis hexahedron.

Specimens of rock crystals, possessing a great limpidity, have often been taken for diamonds. They were all familiar with the Cornish, Bristol, and Irish diamonds, these last being used for ornamental purposes with bog-oak; good specimens of this had likewise been found in Canada. In the entrance-hall of the Museum they would see a large crystal, which a Cornish miner, at great trouble, had taken through a difficult country, imagining

that it was a diamond, and by the sale of it his fortune would be made, and in this delusion he was not undeceived until he arrived in England. There had been various speculations as to the constituents of the diamond. Sir David Brewster, being of opinion that it was composed of vegetable matter, without the admixture of any igneous composition. It is so hard that it cannot be cut, except by its own powder; and some few years since it had been introduced as a most valuable adjunct in line engraving. In the cutting of diamonds, the ancients used always the octahedron. In general, in setting, two-thirds of the diamond would be below the girdle, and one-third above. With rose diamonds, a number of the facets sometimes meet at the top. Many remarks had been made of the value of diamonds and their utility, and, however might be ridiculed the estimate placed on these gems, yet, adopting the commercial axiom, that an article is worth what it will fetch, they would see that diamonds were not to be despised. A model of the Koh-i-noor, previous to its cutting, as well as after that process, was shown and described. A very interesting treatise on the diamond had been written by the late Dr. Murray, of Hull. The value of this stone much increased according to its weight. Thus, if a diamond of 1 carat was worth £8, one of 2 carats would be worth £32, and one of 3 carats, £72. The history of the diamond was one of romances; and when we considered their value, it was not surprising that many had endeavored to search for them, as a lucky find in a moment would enable them to realize a magnificent fortune. Models were shown of various diamonds. The Pitt, or Regent diamond, weighing 136¼ carats, sold by Mr. Thomas Pitt to the Regent Orleans for £135,000. This gentleman had purchased it for £20,000. It had cost him £5,000 in cutting, but he had realized £7,000 from the powder and chips. The diamond in the Russian sceptre, said to have formed the eye of an idol, and stolen by a French grenadier, who had deserted and become a priest of the temple in order to effect his purpose. The Sanci; the Maximilian, belong to Austria, 140 carats, of the value of £150,000; the Nassuck, now belonging to the Marquis of Westminster. The Rajah of Mattan, in Bornea, is said to possess one of the weight of 370 carats. In its rough state the Koh-i-noor weighed 280 carats. Very few diamonds had been found over the weight of 40 carats; and, therefore, when these valuable gems were stolen, detection was always sure to follow, unless they were broken, and thereby their value deteriorated.

In a subsequent lecture, Mr. Warington Smyth treated of the nature of various Salts. Saltpetre was sometimes found pure in nature, and in many of the plains of Hungary, Spain, Egypt, Persia, and Arabia, it could be found in a state of efflorescence. It was not uncommon that in these localities a tract of country which the night before had a complete brown hue, would in the

morning be perfectly white, as if a heavy fall of snow had taken place, and this phenomenon was more particularly observable after heavy rains had fallen. Occasionally they had endeavored to produce it by an artificial process: and during the civil wars in Hungary, when, owing to that country being almost blockaded, there was a difficulty in procuring gunpowder, great attention was attracted to the cultivation, he might call it, of saltpetre. Large quantities were found in the caverns of Kentucky, in Ceylon, and Calabria, and was often extracted from the mortar in old walls. Sulphate of potash, or glaserite, so called from Glaser, a chemist who lived somewhere about 1644, was a volcanic product, and was found very largely disseminated near Vesuvius. Soda nitre, or nitrate of soda, until within the last few years had only been known to exist in books. A Mr. Bollert had, however, written a good account of a large deposit which existed in the district of Tarapaca, in Peru, and he was commercially engaged in utilising it. This extended to a great distance, and the bed was several feet thick: accompanied with it was common salt, and other salts of soda. Natron, or common carbonate of soda, contains 6·75 per cent. of water; it melts readily before the blowpipe, is found in the plains of Debretzin in Hungary, in Persia, Egypt, and Thibet. A variety of this is called in Africa "trona," and is there found in large quantities, so that it is easily cut, and employed instead of bricks for building cottages in Ferzyan. This can be easily understood, as there are seldom any rains there. Its American designation is "urao." Sulphate of soda, or glauberite, sometimes called broignartite, from the researches of an eminent chemist of the name of Broignart. Some of these are found as combinations of sulphate of soda and sulphate of lime. The mineral thenarolite is found near Aranguez, where it is used for the fabrication of artificial sub-carbonate of soda. Borax or boracical soda, so called from an Arabic word, "boros," signifying white, in its crude state is called tincal. Large quantities of this were brought from Thibet, and some interesting observations had been made by Capt. Stracey, of the East India Company's service, on a bed of it in the Himalaya Mountains, above 15,000 feet above the level of the sea. He would next allude to another mineral, which lately had attracted great attention: this was cryolite, from the word "creos," alluding to its easy fusibility. Its color was white, sometimes gray, or of a reddish and blue tint. Its composition was—fluorine, 53·8; soda, 33·35; aluminium, 13·07. It was found at Arksut Fjord, in Greenland, in a vein between two walls, accompanying galena and other minerals. Some had imagined that the dark color was the natural tint, but so little at present was known about it, that he should not like to hazard any definite opinion. Since the experiments of M. Deville it had excited great interest, in consequence of its adaptability for the manufacture of aluminium. It had been stated

that it was likewise discovered in small quantities in the Ural Mountains.

Chloride of sodium, sal-mare, or sal-gemme (common salt), the uses of which were well known, attracts moisture, but remains unaltered in a dry atmosphere. The crystals it formed in evaporation were well known. One peculiar form of its crystals was by the depositing of one cube on the other, so that they formed as it were steps, and these crystals had a similarity of appearance with those of galena and metallic titanium. The lecturer then described the mode of procuring salt artificially by heat, as practised in Spain and other countries bordering on the Mediterranean, and by cold, as practised in Russia, where by successive congelations the water was entirely freed from the salt, and thus it remained in a crystallized state. The Black Sea contained very little salt, the Mediterranean a great proportion. The Dead Sea, which had no access to others, nor any outlet, was impregnated with it to a considerable extent, so much so that out of 1000 parts there were 71 of chloride of sodium, while in the English channel there were only 27. It was the opinion of some authors that all the salt that was in the sea was carried down by the rivers; and Haley had made some experiments, about a century ago, demonstrating the different degrees of the strength of the salt in various parts of the ocean. Bischoff had likewise paid great attention to this subject. There was a considerable quantity of salt in the rocks, and from many of the sandstones the water was strongly impregnated with the mineral. A number of springs are called brine springs, and there have no deeper bore holes been made, whether in India or China, than for this purpose. Some of the rocks of the new red sandstone were specially charged with it. In many places they had regular methods of mining for salt. In England its principal seat was Cheshire. The great object they must always keep in view was to prevent the water from percolating into the mine. And they would remember that a short period since great sensation had been excited by a rumor that the salt mines were giving way. The appearance of rock salt he need not particularly describe to them. The various modes of mining were illustrated by diagrams and explained. Its principal deposit in Europe was at the mines of Vieliczka, not far from Cracow, in Poland. At Maros Ujvar, in Hungary, they had sunk to a depth of 200 feet, and the salt there was found comparatively pure. At Salzkammergut, near Salzburg, in the Bavarian and Austrian Alps, the salt was accompanied with clay, gypsum, and other extraneous matter, and it was with considerable difficulty they were able to separate it. Mr. W. Smyth then described the method by which the water was turned into the mine, and the salt carried away with it, as well as the mode by which the water column was raised. Nearly all the deposits where salt was met with afforded good supplies, but generally it

was necessary that it should be purified by a process of solution and evaporation.

GEOLOGICAL REPORT ON THE TUNUNGWANT COAL FIELD OF McKEAN COUNTY PA. By D. D. OWEN, Geologist.

THE lands which form the subject of this report, of which I have made a survey, are situated in McKean County, Pa., on the waters of the Tunungwant, Tunaette, and Kinzua, tributaries of the Alleghany River, and lie partly in Bradford, and partly in the adjacent Townships of Corydon, Lafayette and Hamilton, and comprise in all about 42,000 acres of land, the northern limits of which extend within about a mile of the New York State line.

A large portion of these lands occupy an extensive plateau, whence arise the branches giving origin to the heads of the above-named streams; the waters of the Tunungwant and Tunaette flowing to the north, while those of the Kinzua flow to the south.

The elevation of this table land is from 650 to 700 feet above the valley of the Tunungwant, near the State line between Pennsylvania and New York. The valley of the Tunungwant at this place—the base line of the railroad surveys of McKean County—is 844 feet above Lake Erie, and 1422 feet above tidewater; hence the average elevation of these table lands is about 1500 feet above Lake Erie, and 2100 feet above tidewater.

The base of the hills of McKean County, for about 150 feet, are composed of green, gray, and olive shales, and sandstones belonging to the age of the Ithaca and Chemung groups of the New York survey; on these repose from 250 to 300 feet of red marls and red argillaceous sandstones, belonging to the old red formations, while about 250 to 450 feet* of the most elevated portion of the country consists of the coal measures, including mill-stone grit and conglomerate.

The sub-carboniferous limestone appears to be represented, in this part of Pennsylvania, only by a few feet of fossiliferous, dark grey limestone, underlying the sandstones and conglomerate at the base of the coal measures.

The main bed of coal of Bradford and Corydon Townships, which lies from 50 to 100 feet below the general level of the table lands, has, until recently, been overlooked, in consequence, probably, of its underlying a conglomerate or pebbly sandstone. A misapprehension in regard to the existence of workable coal under rocks of this description has, no doubt, contributed to this oversight. Though it may be true, as a general fact, that workable coals have seldom been discovered below the *main mass* of conglomerate or pebbly sandstone, at the base of the coal measures

* By reason of the southern dip, the coal measures are from 400 to 500 feet deep in the southern warrants.

of the United States, yet I am able to cite, in my experience, several instances where good, workable coal occurs under the upper members of the conglomerate: for instance, the main coal, from 4 to 5 feet in thickness, worked on the Cumberland River above its shoals, in Pulaski County, Kentucky, which supplies Nashville, lies 40 feet below a pebbly sandstone or conglomerate, and only 150 feet above the top of the sub-carboniferous limestones; and a coal, 2¼ to 4 feet thick, has been worked in Crittenden County, under 60 feet of coarse grit stones, which is locally pebbly, and evidently the equivalent of the upper conglomerate of tidewater; while in Greenup County, coarse quartsoze sandstone, containing small pebbles, can be traced 400 feet up in the true coal measures. The fact is, that conglomerates and pebbly sandstones have been formed wherever there have been sufficient currents or commotion in the waters of deposition to sweep in coarse materials. The *principal* movements during the carboniferous era which established such currents, took place about the commencement of this formation; hence the *great mass* of the conglomerate lies at the base of our coal measures; but locally they have been produced (to a much more limited extent, however,) for some time subsequent to the introduction of the causes which produced regular beds of coal of sufficient thickness to be of commercial value; and this has been the case in McKean County, Pa.: consequently we find a bed of good workable coal lying 30 to 50 feet under one of the upper masses of conglomerate or pebbly sandstones which underlies the table lands of Bradford, Lafayette, and Corydon Townships.

The general dip of the coal measures is a little west of south, towards the valley of the Kinzua, which brings in, in the direction of Lafayette Township, 300 feet of additional strata, including at least three other workable beds of coal, in the south and south-western warrants on the tracts of land on which I am reporting

The vertical geological section represents the order of superposition of the coal measures of McKean County. It includes eleven to twelve different beds of coal in a space of 330 feet of these lower coal measures, lettered from A to M, inclusive. At least four of these are good workable beds, lettered A, E, G, and L.

The lowest of these, A, known usually under the name of the "Splint Vein," averages four feet in thickness, covered generally by eleven feet of bituminous shales, containing, locally, considerable masses or segregations of carbonate of iron, upon which reposes 30 to 60 feet of sandstone, the lower 12 to 20 feet of which contains pebbles. Superimposed on this sandstone, there are from 40 to 50 feet of dark shales known as the "Wilber Shales," containing several thin beds of coal, interstratified with which are some valuable bituminous carbonates of iron or "*black band*" iron ore; then succeeds in the ascending order, 25 to 30

feet of white, brown, and pink sandstone, also containing occasionally small pebbles; on this rests coal E, known as the "Whitman Coal," composed of two varieties of coal, one a hard, bright bituminous coal, with alternate, thin, dull layers; the other a compact cannel coal, measuring in all upwards of five feet in thickness. The roof of this coal is a dark sandstone, charged with disseminated carbonaceous and coally particles, passing upwards into thin bedded sandstones, with rusty surfaces, embracing a thin coal, F, in all about 30 feet.

This rock forms the floor of the next coal, G, with the intervention of very little fire-clay. This is the "Newell Coal." In the space which succeeds in the ascending order of 150 feet, there are two, if not three, beds of coals; but it is not known at present whether any of these are of workable thickness, since no satisfactory openings have been made on them: one supposed to to be from 1¼ to 2 feet thick (H of the section) has been reached on Warrant 2264, a short distance to the east and above the Newell opening, and is very likely the same bed which has been partially opened on Warrant 2256, forty-eight feet above Tidd's house, and 7000 feet in a horizontal distance to the west, and reported to be from 18 inches to 2 feet thick.

Another coal (I of the section) is reported at the bottom of a shaft sunk by Mr. Clarke, on Warrant 3255. This is probably the same bed which has been reached in several wells on the same Warrant, in and about Lafayette corners.

The coal with ore over it reported in a shaft on Warrant 2257, a short distance to the east of Tidd's house, may possibly be a distinct bed of coal from any of these heretofore described; but it is more probable that it is identical either with the "Newell" or "Whitman" vein. The coal L, of the section, known as the "Davis Coal," which lies 30 to 40 feet above K, will yield five feet of workable coal, and, therefore, enters into the calculation of workable coal on all Warrants southwest of its outcrop on Warrant 2255.

In the sequel of this report, the four workable coals of this section will be referred to by the letters appended in the section, viz., A, E, G, L.

The following chemical analyses of these coals exhibit their composition, qualities and practical application:

ANALYSIS OF COAL A. OF THE SECTION.

Specific Gravity, 1·294.

Moisture	2		
Volatile combustible matter	32	Total volatile matter	34
Fixed carbon in coke	59		
Ashes, (gray)	7	Coke	66
	100		100

The ultimate analysis which exhibits the total amount of carbon both in the coke and volatile combustible ingredients, as well as the proportion of other elementary substances of the volatile

combustible matter, gives a still clearer insight into the qualities and properties of this coal.

1st. *Calculated from 100 parts of the raw coal with its natural moisture and ashes:*

Carbon, total in coke and volatile matter	69·272
Hydrogen	4·240
Oxygen with a little Nitrogen	15·488
Sulphur	1·000
Ashes	7·400
Moisture, (hygrometric)	2·600
	100·000

2d. *Calculated from 100 parts, the coal dried at 212° Fahrenheit:*

Carbon	71·110
Hydrogen	4·353
Oxygen and Nitrogen	16·111
Sulphur	1·026
Ashes	7·400
	100·000

3d. *Calculated from 100 parts of dry combustible matter:*

Carbon	76·199
Hydrogen	4·664
Oxygen and Nitrogen	18·037
Sulphur	1·100
	100·000

The proximate analysis of this coal is very nearly the same as that of the coal of Chesterfield County, Virginia Unfortunately we have no ultimate analysis of that coal to enable us to draw a more satisfactory comparison. It is also in this respect very nearly allied in composition to the lower hard coal, Batterly Park Colliery, used in the blast furnace, at the Batterly Iron Works, in Derbyshire, England, and its ultimate elements are very nearly the same as the Macken rock vein of the Welsh coal fields—and the Blanzy coal of France—and the Todd and Crittenden coal forks of the Kentucky River, which occupies the same Geological horizon as Coal A.

It is a coal well adapted for the manufacture of iron, since it will not be driven so fast before the blast as the softer, fat, bituminous coal, and thus be capable of "carrying a good burthen." It contains too much oxygen to be a very rich gas coal; but containing within one per cent. as much fixed carbon in the coke as the Pittsburg, it will be a coal well suited for the grate, since it will make a hot, durable fire, without throwing off sooty flakes. It contains five to eight per cent. more fixed carbon than the average of the Glasgow coals.

Its evaporative power, for equal weights of coal, is about 800, the Maryland semi-bituminous being 1000; its evaporative power for equal bulks about 700. It will take a very high rank for efficiency of action in evaporating water; but for facility of ignition it will rank below the average. The sum of its relative value, taking all these properties into consideration, will be about 3000, Maryland semi-bituminous, of George Creek Valley, being 3625, and Scotch coal 2750.

One pound of coal will produce about nine pounds of steam at 212°, and 9½ to 10lbs. of steam for every 1lb. of *combustible* matter in the coal. Sixty pounds of this coal will produce about

fourteen links of chain cable of 1⅝ inches diameter. It is free from disseminated pyritiferous impurities.

Two proximate Analyses of the Bituminous Coal E, gave:

Specific Gravity, 1·487.

			Total
Moisture	2·		
Volatile combustible matter	38·2	Volatile matter	40·2
Fixed carbon in coke	54·8		
Ashes, white	5·	Coke	59·8
	100.		100·
Moisture	2·		
Volatile combustible matter	31·3	Total volatile matter	33·3
Fixed carbon in coke	64·2		
Ashes	2·5	Coke	66·7
	100.		100·

The bituminous part of this coal is a hard bright coal, resembling the coals of North Staffordshire, used for iron making, and coking for locomotives.

The specimens of the cannel part of this seam have not come to hand, and I can, therefore, give no analysis of it; but from an analysis made by Prof. Chilton, of New York city, I can recommend it as a good coal for the several uses to which cannel coal is applied, especially for gas making, as proved by the results of a trial made by the Manhattan Gas Company of New York city, with this coal.

One ton of 2000 lbs. yielded 9691 feet of gas, and forty-four bushels of coke weighing 1523 lbs.

This coal seems to be variable in the proportion and quality of the two varieties, and has sometimes two clay or slaty partings.

At one locality it was made up as follows:

	Ft. In.
Bituminous coal	.9
Clay parting	·6
Cannel coal	1·5
Black shale or slaty cannel	·3
Bright bituminous coal	1.8
Clay parting	·2
Bright bituminous coal	·9
	5·6

At another location it was made up of the following members:

	Ft. In.
Bituminous coal	1·4
Cannel coal	1·9
Clay parting	·2
Bright Bituminous coal	3·0
	6·3

In the Whitman Well it is reported:

	Ft. In.
Bituminous coal	2·0
Cannel coal	2·0
Clay parting	·3
Bituminous coal	1·4
	5·7

THE ANALYSIS OF G COAL GAVE

Specific Gravity, 1·318.

Moisture	1·5		
Volatile combustible matter	37·5	Total volatile matter	39
Fixed carbon in coke	56.		
Ashes, light gray	5.	Coke, inflated	61.
	100.		100.

The ultimate Analysis of this Coal (G) gave:

Moisture	2·8
Carbon in coke and volatile matter	72·436
Hydrogen,	5·555
Oxygen and Nitrogen	7·709
Sulphur	·500
Ashes	11·000
	100.

Calculated from 100 parts of combustible matter we have:

Carbon	83·740
Hydrogen	6·410
Oxygen and Nitrogen	9·272
Sulphur	0·578
	100.

This ultimate analysis shows this to be a fat, partially coking coal, with a long flame, rich in hydro-carbons, and therefore well adapted for gas making. The proximate analysis is very nearly the same as that of the main coal extensively worked in the Derbyshire coal field, except that it has rather more volatile matter.

THE PROXIMATE ANALYSIS OF COAL (L) GAVE

Specific Gravity, 1·321.

Moisture	1·5		
Volatile combustible matter	39·5	Total volatile matter	41.
Fixed carbon in coke	55.		
Ashes, dark gray	4.	Coke inflated	59.
	100.		10 .

The ultimate analysis gave:

Moisture	2·100
Hydrogen	7.222
Carbon in coke and volatile matter	75·545
Oxygen and Nitrogen	5·133
Sulphur, a mere trace.	
Ashes, red	10.
	100.

Calculated from 100 parts of dry combustible matter this gives:

Carbon	85·846
Hydrogen	8·206
Oxygen and Nitrogen	5·948
	100.

This coal contains more hydrogen than its appearance would indicate. I attribute this peculiarity to the fact that it lies very close to the surface where the specimens were procured, in which position it has necessarily been long exposed to moisture, and, though carefully dried at 212° before being placed in the combustion tube for analysis, it has evidently retained considerable moisture. In its proximate analysis it resembles the coal of the Batterly Park, Derbyshire coal fields.

Taking the total area of workable coals there will be 27,300 acres, which will yield, at a low estimate, 141,215,000 tons of coal from all the various beds united.

ANALYSES OF VARIETY OF ORE FROM ROCKWELL CUT.

1st. *Gray Fossiliferous Carbonate of Iron;*

Specific Gravity, 3·201.

Water, hygrometric	0·80	
Protoxide of Iron	20·09	} =24·01 Iron
Peroxide of Iron	12·04	}
Lime	4·5	
Magnesia	1·4	
Alumina	4.	
Manganese, a trace.		

Carbonic acid	18·	
Phosphoric acid	·50	
Sulphur a mere trace.		
Insoluble silicates	38·50	
Loss and alkalies not determined	·17	
	100 00	

2d. *Variety of Ore from Rockwell Cut; even-textured, dove-colored, fine-grained Carbonate.*

Insoluble silicates	25·	
Protoxide of Iron	36·	=35. Iron.
Peroxide of Iron	9·99	
Corbonic acid	24·66	
Lime	1·5	
Magnesia	1·26	
Alumina	1·	
Phosphoric acid	·3	
Sulphur	·06	
Loss and alkalies not determined	·23	
	100·	

3d. *Variety: medium quality of gray Carbonate, with a few disseminated gravel stones.*

Insoluble silicates	38·5	
Protoxide of Iron	23·236	=27·35 Iron.
Peroxide of Iron	12·244	
Carbonic acid	17·2	
Lime	2·	
Magnesia	1·4	
Alumina	3·5	
Phosphoric acid a trace.		
Loss and alkalies not determined	1·920	
	100·	

4th. *Variety: most earthy part of the gray Carbonate, with minute scales of mica disseminated.*

Insoluble earthy matter	48·5	
Protoxide of Iron	22·61	=23·1 Iron.
Peroxide of Iron	7·86	
Carbonic acid	16·50	
Lime	1·50	
Magnesia	1·40	
Alumina	1·50	
Loss, alkalies, &c., not determined	·13	
	100.	

5th. *Variety: part of the bed converted mostly into hydrated brown Oxide or Limonite.*

Insoluble earthy matter	17·	
Protoxide of Iron	8·05	=48·65 Iron.
Peroxide of Iron	60·455	
Carbonic acid	5·7	
Lime	·5	
Magnesia	·36	
Alumina	·4	
Moisture	3·5	
Loss, alkalies, &c., not determined	·435	
	100·	

Taking the average of these five varieties, we have 31·62 per-cent. as the yield in metallic iron of the bed of the Rockwell cut in the aggregate where it has been reached on warrant 3,904, facing the declivity of Two Mile Run, on the head waters of the Tunaette. The same bed has been reached by a drift on warrant 3,329 on the waters of Minard Run, and is reported also more than twelve miles to the south-east of these tracts in Keating township, where it is of corresponding thickness; hence we are justified in assuming it continuous. Inasmuch as it underlies the A coal 110 feet, it may fairly be considered as having an area of at least 20,000 acres on the tracts of land in question. Allow-

ing it to be only three feet thick, of solid ore, which is certainly a low estimate, since I believe there will be found in practice, 3½ to 4 feet of workable ore, and since it has a specific gravity of over three, then we have in round numbers, 4000 tons of ore on every acre, or 80,000,000 tons on the whole track west of the Tunungwant, capable of yielding upwards of 26,000,000 tons of cast iron, and probably more than one-third of this amount on the warrants on the east side of the Tunungwant, since it, no doubt, has an area of 6,500 acres on that tract of land.

The black band ore interlocated in the shaly space known as the Wilber shales of McKean county, associated with coals C and D, that lie between the sandstone overlying the A coal and the sandstone that underlies the E coal, yielded by chemical analysis the following results:

Specific Gravity, 3·069.

Moisture	·8
Protoxide of Iron	56.25=43·75 Iron.
Carbonic acid	29·95
Lime	1·00
Magnesia	·72
Alumina	2·00
Insoluble silicates	6 50
Sulphur	·025
Bituminous matter, loss, &c.	2·755
	100.

This rich black band ore I estimated to be one foot in thickness, as near as I could judge from a view obtained in the shaft on Lewis's Run, which was partly filled with water at the time I was there. This shaft was afterwards cleared out and inspected by Mr. B. Needham, who reported it to be 18 inches thick.

This rich black band is overlaid by black band shales, eight inches of which yield 14 per cent. of iron, and 2 feet 11 inches, 5·6 per cent.; the succession being as here shown:

		Ft. In.
1.	Earth	6.
2.	Ferruginous shales	8.
3.	Black band, yielding 5·6 per cent	2·11
4.	Light olive shales	·2
5.	Black band shale, yielding 14 per cent.	·7
	Light olive shale	·1
6.	Rich black band shale, yielding 43·75 per cent. iron, 1 ft. to	1·6

THE ANALYSIS OF NO. 5. OF THIS SECTION GAVE

Specific Gravity, 2·61.

Insoluble silicates	53.
Protoxide of Iron	18.=14. of Iron.
Lime	1.
Magnesia	1·45
Alumina	5·5
Carbonic acid, bitumen, loss, &c.	21·05
	100.

THE ANALYSIS OF NO. 3 GAVE

Specific Gravity, 2·502.

Insoluble silicates	71.
Protoxide of Iron	7·2=5·6 Iron.
Lime	0·3
Magnesia	0·907
Alumina	7.
Carbonic acid, bitumen, loss, &c.	13·593
	100.

Though these two last black band shales are not sufficiently rich in iron to be worked by themselves, they would answer as an addition to the furnace in connection with other ores; especially to rich silicious hydrated oxides or limonite ores, which require an admixture of argillaceous shales to form a normal slag, and protect the reduced iron from the oxidizing influence of the blast. They would thus not only subserve this purpose, but increase the product of the furnace by the amount of iron they respectively contain.

The area over which this black band ore extends, may be taken at two-thirds the area of the A coal—say 16,000 acres; this would give 10,000,000 tons of metal from the entire tract.

There are other spaces in these coal measures which may be expected to yield more or less iron ore. The shaly space over the G coal affords specimens of an excellent variety of fine-textured carbonate of the protoxide of iron, the composition of which is shown by the subjoined chemical analysis:

Insoluble silicates	11·5	
Protoxide of Iron	54.	=42·01 Iron.
Carbonic acid	27·2	
Lime	2·0	
Magnesia	1·8	
Alumina	3·5	
	100.	

This ore will, therefore, yield forty-two per cent. of metallic iron. It is reported at different localities, where it has been reached by borings, to be from one to two feet thick. Since I have not been able personally to get a satisfactory view of the thickness of this bed of ore, I am unable, at present, to report definitely in regard to its actual dimensions and extent, but my impression is, from all the data gathered, that it may prove to be a valuable bed of ore over the southern part of the tract.

A drill-hole was put down under the five feet ore of the Rockwell cut, and another ore bed reported below.

More or less ore may be expected in the eleven feet of shales forming the roof of coal A, which yielded 21·72 per cent. of iron in the specimen analyzed as follows:

Moisture	·6	
Insoluble silicates	56.	
Protoxide of Iron	25·2	=21·72 of Iron.
Carbonic acid	10.	
Lime	1·5	
Magnesia	1·64	
Alumina	4·5	
Loss, alkalies, &c	·56	
	100.	

The black band shales over the L coal are too lean to be worked by themselves, as they only contain 6·3 per cent. iron. The analysis gave:

Insoluble earthy matter	77.
Protoxide of Iron	8·1=6·3 Iron.
Lime a trace.	
Magnesia	·72
Alumina	7.
Carbonic acid, sulphur, loss, &c.	7·18
	100.

Coal A and E, and probably L, are underlaid by fire-clays adapted for the manufacture of fire-brick, and other purposes.

In the valley of Minard Run, on warrant 3,332, a bed of fossiliferous limestone occurs, overlaid by schistose argillaceous sandstone. Two to three feet of this limestone are exposed at Minard Run Lick, where a chalybeate spring issues from the junction of this rock and the superincumbent strata. The chemical composition of this limestone is as follows:

Moisture	.5
Insoluble silicates	43·5
Carbonate of Lime	45.
Peroxide of Iron	6·4
Alumina	3·1
Magnesia	·54
Phosphoric acid	·6
Magnesia, a trace.	
Loss and alkalies not determined	·36
	100.

Limestone occupying apparently the same geological position, occurs on warrant 2,321, also on the waters of Minard Run, which, judging from external appearance alone, seemed to be more earthy. The analysis proves, however, that it contains less earthy matter and more lime than that on warrant 3,332:

Moisture	·5
Insoluble silicates	27·9
Carbonate of Lime	67·65
Peroxide of Iron	2·45
Alumina	·55
Magnesia	·73
Phosphoric acid	·18
Loss and alkalies	·04
	100.

There are several spaces in the Tunungwant coal fields to which I beg leave to call attention, as more likely to afford limestone than any other.

Under one of the ore beds below coal A, in the space between coals H and I, about 30 to 40 feet above H, and the space between coals I and K, about 90 to 100 feet above G coal, the first and last of these spaces have afforded limestone in Sergeant township, McKean county.

When we view the geographical position of the Tunungwant coal and iron districts, the attention is at once arrested by its favorable position for supplying a vast extent of populous country with these invaluable minerals, of which it is itself destitute, yet consuming already both coal and iron to the extent of many millions of tons annually.

Stretching as its northern limits do within a mile or two of the New York line, while the heart of these mineral lands is only ten to twelve miles from the same line and only seventy-five miles in a direct line from Buffalo, the value and importance of these mineral lands become apparent, especially when we view their position in relation to the network of railroads and canals either already constructed or in prospective.

By twenty miles of railroad, of which the grading is almost completed, the mineral tract will be brought in immediate connection with the New York and Erie Railroad; there would then be a continuous line of railroad to Buffalo by way of Dunkirk, a distance of 113 miles, by which coal can be delivered in Buffalo at a cost of $2.40 per ton, viz:

Mining, 40 cts., props 2 cts., and roads, 3. cts in mines	45
Opening mines, and contingencies in mines	04
Loading into cars, 2 cts., unloading from cars, 2 cts	04
Use of Cars, repairs, oils, interest, &c	17
Cost of coal delivered in R. R. cars, repairs, &c	70
Freight, 113 miles, at 1½ cent per ton per mile	1 70
	$2 40

During the season of navigation, it may be carried from Dunkirk to Buffalo by water, which would probably somewhat lessen the cost of transportation. But before long a much shorter route will be open, as the Buffalo and Pittsburg Railroad will be extended to Buffalo direct, and with the Buffalo and Bradford Railroad, form a connection with the Sunbury and Erie and Alleghany Valley Railroads, thus affording a through route from Buffalo to Philadelphia, by the former, and to Pittsburg by the latter. The distance by railroad will then be lessened twenty-six miles, so that the cost will be reduced to $2.00 per ton.

The Erie Canal and Lake Ontario, with their numerous connections, will, by the same twenty miles of railroad, be rendered accessible at Rochester.

The distance from the mines to the N. Y. & E. R. R. is	19	miles.
From Tunungwant to Olean	12	"
" Olean to Rochester, by Genesee Valley Canal	110	"
Distance from mines to Rochester	141	miles.

The cost of delivery by this route would be,

Freight, 31 miles by R. R., at 1½c. per ton per mile	46½
" 100 " " canal, including tolls and all expenses of transhipment	1 10
	$1 56½
Add for delivery in R. R. cars, &c	70
Making cost of delivery in Rochester	$2 26½

But by the projected extension of water communication from Olean to the mouth of Tunungwant Creek, the expense would be lessened, and better facilities afforded for the transhipment of coal.

The distance would then be,

From the mines to Alleghany River	17	miles.
" mouth of Tunungwant Creek to Rochester	121	"
	138	miles.

The cost by this transportation would be,

17 miles by R. R., at 1½ cent per ton per mile		25½
121 " " water, at 1c., including all expenses of transhipment, tolls, loss, &c.		1 21
		$1 46½
Add cost of delivery in R. R. cars, &c.		70
Making cost of coal in Rochester		$2 16½

The coals from your mines could be sold much lower than the cheapest coal offered in this city, and by reference to the analytical table, their quality will compare favorably with any bituminous or cannel coals offered in this market or New York city, as well as in Syracuse, where there is an immense consumption of fuel employed in the manufacture of salt, and upon which fuel no state tolls are charged.

The home consumption of coal for the manufacture of oils, &c., (for which purpose buildings and machinery are now being erected in your village), will form no inconsiderable demand, and must create a large and profitable business, as appears from the following extract taken from the "Miner's Journal:"

"The marvellous qualities of cannel coal for the production of oils, naphtha and candle wax or paraffine, are truly astonishing, and would scarcely be credited, were they not fully substantiated by actual experience in Scotland and England, placing the matter beyond dispute. The oil is extracted by a process very similar to that of making gas at our gas establishments, though at a much lower temperature, and the volatile matter leaves the retort as a liquid instead of gas, as in the case where a great degree of heat is used.

"By a process of making, one ton of cannel coal produces about 140 gallons of *crude* oil, which, when distilled, will produce more than forty gallons of *pure* oil, equal to the best sperm oil for burning, lubricating, &c.; twenty-five gallons of naphtha or benzole, and fifteen to twenty pounds of candle wax, more beautiful than, and far superior to sperm, making the product of a ton of this coal worth from 75 to 100 dollars.

"This oil is equal to the best sperm for lubricating and burning, and it has also been successfully used in painting; and when it is mentioned that for lubricating purposes alone the expenditure for oil by the railway companies of the United States and Canada, amounts to over a million dollars per annum, and that this item is increasing at an enormous rate by railway extensions, besides the immense and growing consumption for all kinds of machinery, it will be readily seen that our estimate of the money value of this extraordinary discovery is by no means overrated.

"The burning oil is very limpid: it resists cold better than the purest sperm, does not gum the wick, and gives a clear and brilliant light.

"The lubricating qualities of coal oil are quite unrivalled, so much so, that in the manufacturing districts of England the use

of sperm oil as a lubricator for machinery, has been discontinued, and kerosene or mineral oil is substituted, as being far superior and much cheaper. Mineral oil from the Scotch Boghead Coal or Torbane, was first introduced into the English manufacturing districts in 1852, and was then viewed with suspicion, as being one of a thousand and one impracticable attempts to manufacture a cheap lubricating machinery oil. It was offered at five shillings sterling per gallon."

Dr. Kent, of New York, illustrates the comparative value of light from coal and bituminous shales as follows:

MATERIAL.	Quantity of light from equal measures.	Cost of equal amounts of light.	Retail price per gallon.	Intensity of light.
Kerosene or Oil of Coal,	2.435	$ 4 10	$ 1 00	13.669
Camphene,	1.793	4 85	63	5.625
Sylvic Oil,	.826	6 05	50	1.190
Rapeseed Oil,	1.660	9 00	1 50	5.929
Whale Oil,	.833	12 00	1 00	1.892
Lard Oil,	.706	17 70	1 25	1.640
Sperm Oil,	.850	26 47	2 25	2.025
Burning Fluid,	.390	29 00	87	.551

From these actual results and a reference to the analyses of the different coals, it is evident that for domestic uses. for the generation of steam, manufacture of iron, production of gas, oils —in brief, for every use to which coal can be applied, your lands are adequate to the supply in whatever variety the demands may be made.

When we take into consideration a fact stated to me by a leading citizen of Rochester, that in five years from this time the greater part of the available timber for firewood, will be cut off from all lands lying within fifteen miles in every direction around Rochester, and reflect, at the same time, on the vast consumption of wood by the railroads, and in the manufacture of salt near Syracuse, we see at once how universal must be the introduction of coal as a fuel in Western New York, before the lapse of many years; and there cannot be a shadow of doubt that coal companies located in McKean county, Pa., so conveniently situated for supplying these various cities, and who can deliver their coal at Buffalo at the same price as coal is delivered at Cleveland and Erie, have an unfailing market that cannot be overstocked. "For the city of Buffalo," as a cotemporary writer remarks, "lying at the eastern extremity of the upper lake navigation, and at the western extremity of the Erie Canal, becomes the great interport for the vast amount of agricultural products of the West. The increase of these products requires a constant and rapid increase in the means of transportation towards the Atlantic coast. The debarkation of the cargoes of all the steamboats and propellers at Buffalo, renders it desirable that they supply themselves with fuel at this place, rather than turn aside for that purpose to Erie or Cleveland, the two depots of coal on Lake Erie. The upward freight of vessels from Buffalo to the western ports, bears so small a proportion to the downward freight, that vessels are compelled

to purchase sand for ballast on their outward trips. It is evident that if coal could be obtained at Buffalo as cheaply as at Erie or Cleveland, these vessels would purchase coal for supplying all the lake ports having commercial intercourse with Buffalo."

The city of Buffalo must be the great point for the distribution of the Tunungwant coal and iron. With a present population of from ninety to one hundred thousand, and rapidly increasing; a large manufacturing interest, steamboats and propellers, amounting to more than 100,000 tons, besides an immense tonnage in sail vessels, railroads and channels of water communication, radiating to every point of the compass, extending to remote parts of the country, Buffalo possesses facilities for the sale and distribution of coal and manufactures unsurpassed by any other city in the country. Already the largest grain market in the world, she only requires cheap and abundant fuel to enable her to become one of the most important manufacturing cities on the continent.

The amount of bituminous coal now consumed in Buffalo, and by the steam vessels running from thence, is reported to be not less than 250,000 tons annually, and this is considered a very low estimate.

The population of Western New York, within a circuit of one hundred miles of Buffalo, is, according to the state census of 1855, about 650,000; add to this the population of Canada West, within easy reach of that city by railroads and water, which cannot be less than 250,000, and we have a population of nearly one million, which very soon will be entirely dependent upon these coal fields for fuel.

On the completion of the Erie Canal enlargement, these coals can be transported on it from Buffalo to the city of New York and intermediate points, at a price so low as almost to defy competition. There can, therefore, be no doubt that the demand for these coals will only be limited by the supply.

About 100 feet below the base of the conglomerate and associate sandstones, at the base of the coal measures of McKean county, in the old red formation, there occurs, and can be supplied to an indefinite amount, a pigment of a Spanish brown color, which makes, when washed and mixed with oil, a firm and durable paint.

The soil derived from the old red formation, especially near its junction with the coal measures above, and Ithaca and Portage group below, is remarkably productive, yielding thirty to thirty-five bushels of wheat to the acre, and in favorable years even as high, in some instances, as forty bushels; and that upon abrupt slopes of the hill sides, where it might at first be supposed that the soil would be so much washed as to be comparatively barren.

The soil of the table land where it is derived from the calcareous, carbonaceous shales mixed with the *debris* of the adjacent

sandstones, is hardly less productive; and, perhaps, better adapted for oats than any of the lands of McKean county.

The lands which form the subject of this report are not only valuable as mineral and agricultural lands, but also for the timber, viz., pine, hemlock, and hard woods, chiefly maple and beech.

It is estimated by those who have made the timber business their trade, that 15,000 acres of these lands will yield of hard wood, fifty cords to the acre, and 10,000, twenty-five to thirty cords to the acre. Forty cords to the acre may be estimated of hard wood, on an average of the whole tract, suitable for making charcoal for blast furnaces. This would be equal to 3000 bushels of charcoal to the acre, equal to the production of ten tons of cast iron to the acre from the whole tract. This is exclusive of the pine; of this kind of timber there are at least 2000 acres on warrants 4,910, 4,909, 4,908, 4,907, and 4,906, that will cut 20,000 feet to the acre, and about 3000 acres more that will cut 10,000 feet of lumber to the acre.

There are, moreover, vast forests of hemlock, which are destined in a few years to be almost as valuable as the pine timber is at the present time.

But on the resources of this country in timber you will have a more special report from Mr. B. Needham, which renders it unnecessary for me in this place to enlarge farther on this subject.

When we take into account the mineral resources of the Tunungwant coal fields, their agricultural capabilities, together with the immense forests of valuable timber, almost as yet untouched, and their geographical position in connection with the lines of railroads and canals that intersect Western New York, with which it is just about to be brought in connection by the completion of the Buffalo and Bradford Railroad, it will be difficult to select a country whose future prospects hold out greater hopes of quick and profitable returns to those who may first embark in the coal, iron, and lumber business, or whose commercial prosperity is so certain, if called into activity by the proper class of enterprising and industrious population.

But the advantages which will accrue are not alone to the enterprising individuals or companies who may be instrumental in opening up the resources of this part of Pennsylvania, which has for so long a period been almost overlooked. The lake shore country, the whole of Western New York, and Buffalo in particular, are to derive immense benefits; since it is to furnish that country with a reliable store of cheap fuel of excellent quality, which will be a boon not only individually to every inhabitant of this rich and flourishing country, but must inevitably be the means of introducing and fostering every species of manufactures which its great agricultural resources imperatively demand, and which nothing can now delay but a deficient supply of cheap fuel.

ART. VIII.—SCOTCH IRON MANUFACTURE.

BETWEEN thirty and forty years ago, when the iron trade in Scotland received a fresh impetus by the introduction into the business of various improvements, and a new raw material, hitherto overlooked or considered impracticable, a family of the name of Baird owned a small farm of some thirty or forty acres between seven or eight miles from Glasgow.

This property was underlaid by a bed of coal—the Monkland coal seam—which was worked to a very limited extent by the proprietors, and hauled by *single cartloads* to the Glasgow market. Partly from this small coal business, and partly from the products of the farm, the family barely made a living; finding it often difficult to make the two ends meet. So limited, indeed, was their means, that the father considered the business inadequate to the support of the family, so that as the two eldest sons grew to manhood, he urged upon them the necessity of seeking a livelihood elsewhere, in some other business.

During the excavations for the coal on the farm, a kind of ironstone had been encountered, and considerable quantities taken out, which lay scattered in piles at the mouth of the pit, as worthless rubbish, encumbering the ground.

At one of these family meetings, while counselling in regard to future prospects, it was suggested by the eldest son that perhaps they might be able to make iron profitably from some of these waste ironstones. The father, supposing the amount of capital required to commence such a business entirely beyond their limited means, thought, at first, such an enterprise out of the question. Finally, however, by uniting the whole savings of the family, and effecting certain small loans, the father and sons managed to erect, with the sum of £1200, an iron furnace for the production of pig iron from their black-band ironstone and coal.

The business succeeded beyond their expectations; in a few years they were not only able to pay off the borrowed capital, but had laid up a surplus sufficient to erect another furnace. Soon they were able to purchase adjoining coal and iron property, and lease the mining right for black-band ore on other estates. This being about the time of the first successful introduction of that species of ore for making iron, its real intrinsic value was, as yet, but little known; so that they were enabled to maintain mining rights for this ore at a shilling a ton, while some of their neighbors in the same business, starting later in this branch of the trade, paid 15, 16, and even as high, in some instances, as 18 shillings per ton for their mining right or lordship.

Progressing in the business under such favorable auspices, wealth flowed in fast, and they were enabled to extend their business rapidly, and put into operation furnace after furnace in rapid succession, and add, from time to time, considerably to

their mineral lands. Ultimately, on their well known estate of Gartsherry, celebrated throughout Scotland, there were sixteen furnaces in blast, besides three or four more in Ayrshire.

That Baird family are now in the annual receipt, from their coal and iron works, of a clear profit of half a million of pounds sterling, or two and a half millions of dollars; wielding a moneyed influence beyond even the princes of the land.

Let it be forcibly impressed on the minds of my readers, that this immense wealth was not amassed by speculation, but by legitimate earnings from a business producing an article of the greatest intrinsic value—a metal to which Great Britain owes, perhaps, more than to any of her other numerous manufactured products, her national greatness—and giving, at the same time, constant employment to whole towns of industrious inhabitants; the material from which all this wealth was extracted, a mineral taken from the bowels of the earth, regarded for centuries as worthless.

Thus it is that Great Britain has risen to the apex of commercial prosperity; thus it is that the United States, at this very moment, is paying her "a golden tribute" of $30,000,000 annually for imported iron alone; thus it is that her iron manufacturers can raise their millions with as much ease as we our thousands.

JOURNAL OF MINING LAWS AND REGULATIONS.

The Collins Company *against* Brown.	Vice Chancellor's Court, London, June 11, 1857, Before Sir William Page Wood.

This was a demurrer to an injunction bill. The plaintiffs were members of a company of edge tool manufacturers, the company having been formed in the State of Connecticut, North America. The defendant, Mr. Charles Brown, was a saw and steel manufacturer at Sheffield. The Collins company alleged that the defendant had made, sold and exported tools or articles manufactured so as to resemble those of the plaintiffs, and having marks or labels, similar to, or only colorably differing from those of the company. They sought an account of the profits which had been made by Mr. Brown, a delivery up of tools, and articles, stamps, plates, blocks, and labels in his possession, and the effacing and destruction of such marks or labels, &c. They also sought an injunction to restrain the defendant from stamping or engraving on tools manufactured for or sold by him, the words "Collins & Co., Hartford, cast steel, warranted," or other words tending to mislead the public into the belief that such tools were manufactured by the Collins Company. The bill sought, also, to restrain the defendant from selling, exporting, consigning, or otherwise disposing of any tools or articles having on them any such words, marks, or labels as before mentioned.

Mr. Rolt and Mr. Eddis were for the plaintiffs.

The court having yesterday decided this case in favor of the plaintiffs,

Mr. Martendale, who was for the defendant, now stated that he was instructed by his client to make a public apology for any injury which the plaintiffs might have sustained by the infringement of the trade mark.

The Vice Chancellor said it was probable, if not evident, that Mr. Martindale's client had been imposed upon by others. It was creditable to him to instruct his counsel to make the apology. Next to offences of an indictable nature, he knew of none more disgraceful than this.

Collins Company vs. *Cohen.*—This was a similar bill for the same objects, to which there was a demurrer. The defendant, Frederick Cohen, was a merchant at Birmingham. The plaintiffs alleged that they had sustained injury by the importation of tools and articles made to resemble their own into America, Cuba, Australia, and other places. The tools so wrongfully manufactured in imitation of those of the plaintiffs, were hatchets, picks, adzes, &c., having on them marks and labels resembling those of the Collins Company.

Mr. Rolt and Mr. Eddis were for the plaintiffs.

Mr. Cairns and Mr. Clement Swanton were heard in support of the demurrer, and urged that the present case must be judged of by analogy to those of patents and copyrights, in which it had been held that no property could vest in a foreigner so as to entitle a party to sustain an injunction. If the present case were rested on fraud, the bill itself showed that if there were any, it had not been perpetrated in this country, but in America, where, it was to be presumed, the courts had power to deal with the case, so as to prevent injury to the plaintiffs from the refusal of the courts in this country to interfere.

The Vice-Chancellor said the case was perfectly free from doubt. A similar case had come before the late Lord Langdale (" Perry *vs.* Truefit," 6 Beav., 73), in which his Lordship laid down the doctrine thus :—" I think the principle on which both the courts of law and equity proceed in granting relief and protection in cases of this sort is well understood. A man is not to sell his own goods under the pretence that they are the goods of another man; he cannot be permitted to practise such a deception, nor to use the means which contribute to that end. He cannot, therefore, be allowed to use names, marks, letters, or other *indicia*, by which he may induce purchasers to believe that the goods which he is selling are the manufacture of another person. I own it does not seem to me that a man can acquire a property merely in a name or mark, but whether he has or not a property in the name or mark, I have no doubt that another person has not a right to use that name or mark for the purpose of deception, and in order to attract to himself that course of trade or that custom, which, without that improper act, would have flowed to the person who first used or was alone in the habit of using the particular name or mark. The present was a case wholly distinguishable from copyright cases. The question was fraud or no fraud. The subject of every country had a right to apply to the courts of this country to arrest at the fountain head a fraud which operated injuriously on another. It would be very unfortunate should this not be the case at any time.

COMMERCIAL ASPECT OF THE MINING INTEREST.

There is some appearance of an approaching movement in the stocks of mining companies. Within the last five years the gold-mining interest of the Southern States has entirely failed to obtain any attention from the public. The hundreds of gold-mining companies organized between 1844 and 1854,

mostly entered into extensive mining operations involving heavy expenditures, with very small cash capitals, which soon became exhausted before any useful points of progress could be obtained, and, consequently, the bulk of the companies have been wound up. A portion, however, of the gold companies have survived the fate which attended the many; having managed their affairs with some degree of tact and management. Many have successfully sunk shafts, and have obtained sufficient gold to pay expenses, and continue their works. Some have actually yielded dividends, and others promised fairly. Among the gold companies that have never stopped working, we notice the following:—The Gardiner Gold Co., the Melville, the Dorn, the Gold Hill.

There is more activity in the stocks of the Melville, the Dorn, the Gardiner, the Gold Hill, and the Aberdeen. The transactions at the mining board are mostly in these, and in North Carolina Copper Company stock. We observe that the Georgia Gold Company has suspended mining. This company is, however, stated to be out of debt, its mine paid for, and the president has $3000 dollars on hand. He wants to sell the property. The president is Mr. Smith, of the firm of Smith & Noble, Pearl street, near Wall. The same gentleman is also president of the Gold Hill Mining Company, which paid a dividend of 5 cents per share on the 25th of March, and is expected to pay another equally valuable dividend in October.

Of the copper companies, the Pittsburg or Cliff Company, which is one of the most prosperous companies ever formed, has declared a half yearly dividend of 15 per cent. now in course of payment. This company and Minnesota Company still take the lead in the copper companies. A few others are doing moderately well, such as the Isle Royale in the Lake Superior copper regions, but the mass of companies formed there a few years ago, are doing ill or are closed. Of the Tennessee mines, the Eureka Mining Company has taken the lead. A dividend of 5 per cent. was earned during the first half of the year, and paid on the 1st July. This company's mines yield 160 to 170 boxes of copper monthly, or about 17,000 lbs. The capital is $500,000, in 10,000 shares of $50 each. The president is Josiah Macy. For the year ending 31st March, they obtained $128,158, by sales of ore regulus and metal.

The North Carolina Company continues working, selling all its products to a Boston copper company, which enables it to pay expenses, and officers' salaries, but at present produces nothing to the stockholders; and its stock sells at about 26 cents per share of $100.

The Tennessee mining companies, other than the Eureka, mentioned above, are about to be consolidated into one, with a capital of $2,000,000.

We have seen a circular of the Etna Mining and Manufacturing Company, incorporated by a special charter from the State of Tennessee—capital, $500,000. The property of the Etna Mining Company consists of 18,000 acres in Marion and Hamilton counties, Tennessee, and known as Raccoon Mountain. The Nashville and Chattanooga Railroad runs for eight miles through the property, and the Tennessee River for five miles. They have a railroad communication for market onthe north-west to Nashville and the intervening places; on the north-east to Cleveland, Athens, London, Knoxville; on the

south-east the State of Georgia. The minerals on the property consist of coal, iron, fire-clay, lead, &c., &c. The company intend at present only to mine coal and manufacture coke.

The coal companies are still the most prominent of all mining companies. Reading takes the lead, and is the most productive. The Pennsylvania Coal Company has stopped paying dividends, and its stock, from a premium, has fallen to 60. The reason assigned by the company for suspending dividends is that its increased business has required an increase of cash funds to transact it, as its business is done on a credit of six months, besides which, the directors have paid off some incumbering mortgages on its coal lands.

The profits for the year ending 1st May, 1857, are stated at $820,918, equal to 10 per cent. on the capital stock. The stock of the Cumberland Coal Company has fallen to 13 or 14 per cent. The president in his annual report for the year ending 1st May, states the balance of assets at $266.075, after deducting its funded debt of $467,000, and its floating debt of $205,186. It mined 202,067 tons of coal during the year (against 189,760 tons the year before); which netted, after expenses deducted, $88,467 75.

The stock of the Delaware, Lackawanna, and Western Railroad Company, has occasionally been sold at 50 per cent. from sales forced at the Board of Brokers; but there is none in the market offering. The company has adopted the policy of paying 7 per cent. interest on dividends on its capital; and the earnings justify it. The company mined and sold last year coal which yielded $1,060,964, which produced a net revenue of $148,207.

The Mechanics' and Traders' Coal Company has coal mines in Virginia, Augusta county, and consist of 1,660 acres, free from all debts and encumbrances. The capital of the company, is $500,000 in 100,000 shares. The company is offering for sale a plat of land in Cedar Creek village, in Cedar Creek Valley, near the junction of the valley of the north and south branches of the Shenandoah, 90 miles from Washington. The plat is laid off into lots, 25 by 160, or 26 lots in a block, and is offered at $6 per lot, or $144 per block. With every lot sold, the company gives one share of the mining stock.

The Sonora Silver Mining Company are offering a few shares of their stock. The office of this company is located at Cincinnati, the property lies near Tubac in the Gadsden purchase, and is reported as very rich. The company was organized by gentlemen of character and experience, and familiar with that section of country.

NEW YORK COAL MARKET—August 24.

The supply of domestic coal is in excess of the demand, and prices are lower; the stock is accumulating rather faster than at the corresponding date last year; the consumption is less, owing to the dull state of trade with manufacturers, and families supply themselves less freely for the same reasons. The large arrivals in prospect induce buyers to hold off, but with the great improvement in trade which is likely to follow, a large harvest of all of it will be required. The increased receipts over last year is as yet very slight. The demand for shipment has continued brisk, but at easier rates; sales by the cargo $3 65 a $4 60, and from yard $4 10 a $5 per ton. Foreign is scarce,

and Liverpool is better; sales of 150 tons Cannel, $10 50, and 580 tons Orrel, $8 50, 4 mos. Sydney is quiet, and prices are unsettled.

BOSTON COAL MARKET—August 20, 1857.

(From the Boston Courier.)

Coal—Duty—From all the British Provinces, N.A., free; from any other foreign country, 24 per cent.

In English Cannel the sales have been confined to small lots, at $11 50 a $11 75 per chal. cash. Pictou and Sydney coal remain without change. The bulk of the Pictou arriving continues to be delivered on contract, and some large sales at $7 00 a $7 25 per mine chal., cash. Anthracite has been in good retail demand at $7 00 per ton.

Cannel ....chal	11 00 a — —	Sch'kill red ash................	5 75 a — —
Newcastle.................none	— — a — —	do. lump..................	6 00 a 6 25
Orrel ....none	— — a — —	Lehigh, lump..................	6 25 a — —
Sydney....mine chal	7 10 a 7 25	Lackawanna	5 50 a 5 75
Pictou.....mine chal	7 20 a 7 25	*Retail Prices.*	
Pictou. fine mine chal	5 25 a 5 50		
Sch'kill white ash, ton	5 50 a 5 75	Anthracite, white & red ash...	7 00 a — —

NEW YORK METAL MARKET—August 24, 1857.

Iron.			Nails, cut..................	3½ a 3.70c.	6 mos.
Pig, No. 1, Scotch..........	$29 to 30	6mos.	Wire, bright & an.......	50 a 55	"
" 1, Anthracite.......	26½ to 28	"	Telegraph...........	5½ a 5¾c	cash.
" 2, "	25 a 26		Tin, Gov't, Banca........	40c a	"
" 3, "	24½	"	Straits................	34½ a 35½	"
" 1, Charcoal.........	29 to 35	"	Banca, to arrive, now due.......... ..	36 a 37	"
Bar, refined....	65 to 67½	"	*Tin-Plates.*		
Common English.......	55 to 58½	"	½ X Charcoal............	11½ to 11¾	6 mos.
Band.........................	72½ to 75	"	I.C. Coke................	9½ to 10½	"
Hoop.........................	72½ to 76½	"	Ternes, I.C.14x20 Char..	10½ to 10¾	"
Spike Rods.................	60 to 67½	"	" Coke...	9½ to 9¾	"
Railroad Bars..............	55½		Zinc, sheet...............	8¼cto ..	"
Boiler Plate, English........	3½ to 3¾c	"	Spelter....................	7¼cto...	"
" Amer.........	4 to 5½c	"	*Lead.*		
Sheets, Russia...............	11½ 12 c	"	Refined Eng. & Ger......	6½ a 6¾	cash.
" English, singles......	3½ a 3¾c	"	Soft Spanish.............	6 1-16 a 6½	"
" " doubles.....	3½ a 4½c	"	Copper, Ingot...........	24½ a 25½c	4 mos.
" Russia, to arrive.....	11 a 11½c	"	Chili Pig.............	24c	6 mos.
Steel.			Sheathing...........	27½ a 28½c	"
Cast	14 a 15½c	"			
English Spring..............	100 a 110c	"	Antimony................	12¾ to 13c	cash.

BOSTON METAL MARKET—August 20, 1857.

(From the Boston Courier.)

The market for Pig Iron continues dull in the sales of Gartsharrie and other brands, No. 1, Scotch, at $29 a $30 per ton, 6 months; and American Pig is selling at $27 a $28 per ton, 6 months. In Russia Sheet Iron there have been sales at 11c. per pound, 6 months. Bar iron is quiet, with sales of common and refined English at $60 a $70 per ton, 6 months.

Russia P. S. I. Old Sable per ton of 2,240 lbs., 6 mos	.. .. a	Scotch pig. 1st quality..............	29 00 a 30 00
		do other qualities..............	28 00 a 29 00
		American pig, No. 1..............	27 00 a 29 00
do. New Sable..........	.. .. a	Russia Sht, pl'd, per lb..........	.. 00 a .. 11
Swedish, ass'd com.........	100 00 a 105 00	English do..........................	.. 4 a .. 4½
Square and extra sizes.....	110 00 a 117 50	Penna. boiler, 1st qual..........	.. .. a .. ..
Eng. round, flat and square	57 50 a 60 00	do 2d do..........	.. .. a .. ..
Eng. round, refined........	67 50 a 70 00	Brandywine do. best..........	.. 5½ a .. 5¾

Copper.—Yellow Sheathing Metal at 22c per lb., 6 months. Sheathing copper at 27 a 28c. per lb., 6 months. Pig copper, sales of 125,000 lbs. Valparaiso at 23½c. per lb., 6 months. Refined copper, large sales in New York, comprising 1,200,000 lbs., at 23 a 23½c. cash, for Baltimore, and 24 a 24½c. for Lake superior, 4 months.

Lead.—There have been sales of 75 tons Spanish, in bond, at 5½c. cash. Lead pipe and sheet lead are selling at 7½c. per lb., cash.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

SCHUYLKILL.

The quantity of coal sent by railroad and canal from Jan. 1 to Aug. 14, 1857, is:—

	Tons.
By Railroad	1,209,323
" Canal	684,260
Total by Canal & R. R.	1,893,583

Shipments to same period last year:

By Railroad	1,333,244
" Canal	612,000
	1,945,244
	1,893,583
Decrease in 1857, so far	51,661

LEHIGH COAL TRADE FOR 1857.—*From Miner's Journal, Pottsville.*

Total amount of shipments for 1857, to July 23d:

By Canal,	Tons.
Lehigh Coal and Nav. Co.,	199,970 06
A. Lathrop and others	1,035 00
Spring Mountain Mines	19,152 13
East Sugar Loaf do	10,935 12
Coleraine do	27,109 13
Stafford do	510 11
N. York and Lehigh Coal Co.,	13,995 11
German Penna Coal Co.,	6,729 15
South Spring Mountain Coal	8,867 18
J. B. McCreary & Co. N. S. Mt. Coal	4,503 18
Beaver Meadow Coal Co.	72 12
Hazleton Coal Co.,	50,031 02
Cranberry Mines	30,263 09
Diamond Mines	14,068 08
Council Ridge	19,317 08
Mt. Pleasant Coal Co.,	2,234 05
Buck Mountain Coal Co	42,085 03
Wilkesbarre Coal Co.	700 05
Wyoming Coal	5,750 15
Hartford Coal Co.,	14,060 05
Total	471,994 04

LEHIGH VALLEY R. R.

Spring Mountain Mines,	74,622 09
East Sugar Loaf do	60,382 12
N. York & Lehigh do	24,137 08
Council Ridge do	40,833 11
German Penna. do	6,307 19
Coleraine & Stafford do	32,120 03
Dolbin & Dehaven do	4,862 15
Hazleton do	26,552 02
John B. Mc Creary & Co	3,375 06
	273,194 05
	471,994 04
Total	745,188 09

Shipments during same period, last year:

By Railroad,	75,606 09
By Canal	620,358 07
	695,964 16
	745,188 09
Increase in 1857, so far	49,223 13

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the Month of July, 1857:

	Month.	Total.
Union Canal	21.157 08	98,724 09
Swatara Railroad	15,226 13	73,248 07

LYKENS VALLEY COAL TRADE FOR THE WEEK ENDING AUG. 1, 1857.

Lykens Valley Coal Company	1,588 tons.
Previously this year	31,447 "
Short Mountain Co. for week	1,734 "
Previously this year	24,582 "
Total	59,381 "

LACKAWANNA COAL TRADE.

Coal transported over the Delaware, Lackawanna, and Western Railroad for week ending Saturday, Aug. 1, 1857:

	Week.	Season.
Shipped North	6,445	117,439
" South	7,769	184,888
Total	14,215	302,328
Coal shipped to the same period last year		12,878

DELAWARE AND HUDSON CO.'S COAL TRADE, FOR 1857.

	Tons.
Up to Aug. 15	270,688
Last year	252,376
Decrease this year	17,769

PENNSYLVANIA COAL CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Aug. 15th	242,709
Last year	288,457
Decrease so far, this year	24,449

TREVORTON COAL TRADE FOR 1857.

	Tons.
Up to Aug. 15th	56,129

BROAD TOP COAL TRADE FOR 1857.

	Tons.
Up to Aug. 15th, 1857	48,727

MARYLAND COAL TRADE.

Shipments of coal for the week ending Saturday, Aug. 8th, 1857: By the Cumberland Coal and Iron Company's Railroad.

	Week.	Year.
Cumberland Coal & Iron Co	3,888	88,616
Hoffman Mines	384	861
Ætna Coal Co	410	10,144
Total	4,684	99,622

By Cumberland and Pennsylvania Railroad:

	Week.	Year.
Frostburg Coal Co	421	14,746
Borden Mining Co	1,866	39,897
Alleghany Coal Co	1,202	24,343
Union Coal Co.	....	721
	3,490	79,709

Total from the Frostburg region for the week, 8,175 tons; and since January 1st, 179,332 tons.

By the George's Creek Coal and Iron Company's Railroad.

	Week.	Year.
Franklin Coal Co.	1,901	26,419
Barton Coal Co.	....	302
Swanton Coal and Iron Co.	....	3.433
Pickell Coal Co.	....	4,329
American Coal Co.	2,969	53,123
C. E. Detmold	1,330	19,309
George's Creek Coal and Iron Co.	2,533	42.797
Total	8,734	149,715

By the Hampshire Coal and Iron Co's. Railroad.

Hampshire Coal & Iron Co.	2,231	85,808

Total from George's Creek region for the week, 10,966 tons; and for the year, 185,523 tons.

Total from the whole coal region for the week, 19,142 tons; and for the year, 364,855 tons.

PENNSYLVANIA COAL COMPANY.

From the report of this Company we learn that the Directors have concluded to pass the usual half yearly dividend, and we think judiciously. The following extracts from the report are the substance upon which the Directors based their conclusions.

Owing to the considerable increase in the business of the Company, requiring additional working capital, and in view of the absorption of a large amount of such capital within the last two or three years by payments on bonds and mortgages given upon coal lands at the time of purchase many years since, and on new purchases of such lands whose value and position with respect to other lands owned by the Company rendered their acquisition indispensable, and for other objects of permanent value which have increased its assets, and the necessity of retaining the present resources of the Company to conduct its largely increased business without incurring a floating debt for the amount, the Board has come to the conclusion to omit the declaration of a dividend at this time, being convinced that such a course will best subserve the permanent interests of the Company, and consequently of its Stockholders.

The Company has at no time possessed more intrinsic value than at present. Its assets are worth much more than its entire capital, its coal lands having appreciated very largely over their cost.

As the Company is enabled to earn 10 per cent. on its capital at the present low prices of coal, which must be regarded as minimum and temporary, any increase of price which may be realized in future years on the large quantity the Company is prepared to bring to market, must tell very strongly upon the profits of the business.

Statement of the business of the Pennsylvania Coal Company for the year ending May 1, 1857:

	Cr.
To coal on hand per last report, and cost of coal mined in 1856, &c.	$606,267 64
To road expenses	856,116 88
To canal freight	653,559 09
To tolls paid Delaware and Hudson Canal Co.	539,120 75
To Port Ewen expenses	52,614 29
To State tax on dividends	16,000 00
To interest on $300,000 mortgage Bonds	42,000 00
To salaries, current expenses, &c., New York office	28,114 97
To coal yard and harbor expenses, rents, depreciation of tools, &c.,	111,719 66
Balance	320,913 66
Total	$2,726,426 94

	Dr.
By sales of coal	$2,466,018 64
By amount received for transportation over company's road, profits on barges, &c.	58,725 46
By coal on hand May 1, 1857	201.682 84
Total	$2,726,426 94
By balance	$320,913 66
The earnings of the previous year were	$342,364 08

We add a short extract from the *Express* of this city relative to this Company.

"The contemplated connection of the Pennsylvania Coal Company road with the Erie road, in the neighborhood of Lackawaxen, has been under consideration for a long time, and its consummation would probably result in profits to the Pennsylvania Company large enough to content their shareholders for all delays in dividends necessary to accomplish it. The road will be about thirteen miles long, and cost say $500,000. The advantages to the Erie road by such an addition to its business, can hardly be estimated. When the road was revived by the subscription to its present stock, one of its leading sources of income was expected to be found in the transportation of coal.

"The greater demand upon the means of the Company to provide for other and then more profitable freight, and the existence of contracts which precluded Coal Companies near the line of the road from using an outlet to market other than the Delaware and Hudson Canal, have prevented the acquisition of this desirable branch of business. When the Long Dock Company is ready to offer its facilities to the Erie Road—which we are glad to be able to say will be done speedily—there will be released partially the most desirable coal station known in the history of the trade—the dock at Piermont, open the entire year to commerce, and capable of accommodating and dispatching an enormous fleet of colliers. Three points would be open to the coal trains of the road—Newburgh, Piermont and Jersey City—at a rate per ton that will allow the Pennsylvania Coal Company to compete with the coal brought by the Delaware and Hudson Canal.

READING RAILROAD.

The following from a reliable source, exhibits the financial conditions of this great artery of the anthracite coal trade:—

It has been in operation fifteen years; it has cost $19,163,151; its stock and mortgages amount to $11,320,541 22; its bonds and all other indebtedness are $7,842,610 68. Its tonnage last year was 2,815,715 tons; its gross receipts were $3,913,742 08; its expenses were $1,568,188 80; and its net profits for the year were $2,689,385 52. Its dividend fund was $1,520,291 12—equal to 14 3-4 per.cent. on its stock; and its dividend was eight per cent. in cash. This year it has paid four per cent. in cash, and in January next it will divide four per cent. in cash, and at least three per cent. in stock, the earnings of the sinking fund.

During the period it has been in operation it has delivered 19,008,915 tons coal, and its gross earnings amount to $31,348,915—about $12,185,764 more than its cost; and after deducting its expenditure, (13,547,080,—under 45 per cent. of its earnings,) its net income is $17,801,935—equal to 188,428 per mile.

During the last five years its capital and debts increased 11 1-2 per cent., and its gross receipts 57 1-2 per cent, and during the last five years carried 86,991 tons more than it did in the first ten, and during the last five the earnings amounted to $2,644,557 more than the earnings of the first ten years.

Its outside business,—that is, its passengers and promiscuous freight—is equal to 54 3-4 per cent. on its expenses, and now that the connection through the Lebanon valley is made with the Pennsylvania Central, it is believed the

outside business will be hereafter equal to the entire expenses. The present capacity of the road is 4,000,000 of tons, besides the passengers and freight."

THE RUSSIAN GOVERNMENT AND THE COAL TRADE.

The Russian Government have made concessions to three companies, of extensive coal fields on the River Don, reserving to itself, however, a large interest in the undertaking. The coal is of the same quality as the Welsh, and Messrs. Charles Mitchell & Co., and other extensive iron shipbuilders on the Tyne, are engaged in building a large fleet of lighters, tug steamers, and screw colliers, which will be sent out to the Black Sea this summer, to develop the coal trade of Southern Russia. The coals will be towed down in lighters, and shipped on board the screw steamers, and by them conveyed to the commercial ports in the Black Sea. The screw steamers will be of 1000 tons each, and upwards, and will be fitted up with cranes, and all the modern improvements for economizing labor. Like our own screw colliers, these vessels will be fitted to render great service in transporting troops in the event of war.

IRON AND ZINC.

IRON WORKS OF PENNSYLVANIA.

The Iron works of Pennsylvania are prominently brought forward by the annexed extracts from a correspondent's letter to Col. J. W. Forney's new paper "The Press." They are very interesting, and well worthy of being preserved in the pages of this magazine:—

Though as the *history* of iron forms no part of my present design—which in itself, however, affords ample material for an article of peculiar interest, and shall claim our attention at some future time—I will at once pass from its discovery, and, at the risk of announcing a fact with which the reader is already familiar, state that, next to England, the United States produce and consume more iron than any other nation in the world. This superiority on the part of England, however, can necessarily be of but short continuance, as a slight glance at the figures will serve to illustrate.

In the year 1740, only 117 years ago, the whole iron production of England was made from fifty-nine furnaces, averaging 249 tons each, or a value of 14,691 tons in all. From the year 1740, during an ensuing period of 115 years, it has been ascertained by careful calculation that the production of iron had increased seventeen fold; so that we find that the production and consumption of iron on a large scale is of comparatively recent date even in England, which fact is of course attributable to the immense impetus given to the demand for this most useful of metals, by the introduction of steam as a motive power, and the consequent multiplication of railroads in nearly all parts of the world.

In accordance with what has been already stated, the manufacture of iron in England, in the year 1855, amounted to upwards of three and a half millions of tons, whilst in the United States there were manufactured in the following year just one million tons—a statement which I think will easily bear the construction, when we consider the unequal length of the race already run between the two countries, that the day is not far in the future when the manufacture of iron in this country will greatly exceed that of England.

But when we come to understand, that out of the one million tons manu-

factured in this country, in 1856, *three hundred and eighty thousand tons*, or about thirty-eight per cent. of the whole amount, was produced in the State of Pennsylvania, she need have no stronger vindication of her claim to the title of *the iron State of the Union* than is here afforded. This amount of iron within the limits of our own State, in a single year, and which amount, even large as it is, is but the beginning of the broad destiny daily opening up before her in that direction, is actually larger than the production of iron in any nation of Europe, excepting England, France, and Prussia.

But to direct our attention more exclusively to the locality designated at the head of this article, it is proper to remark, first, that, great as the nominal resources of Pittsburgh and her surroundings undoubtedly are, especially in the articles of coal and iron, yet, from some cause or other, the ore of the latter is mainly mined and converted into pig-iron at distances more or less remote from her works.

The regions from whence she draws her supplies mainly are, first, what is called the Alleghany region; also the Anthracite region, which is east of the Alleghanies; the Hanging-Rock region, about three hundred and fifty miles from Pittsburgh, on the Ohio river; also, from Tennessee and the region of the Juniata, together with limited supplies from the Monongahela section of country, Missouri, and other sources. From this it will be understood that smelting furnaces form no part of the Pittsburgh iron works, for the reason that converting the ore into pig iron in regions where fuel can be obtained at moderate cost, can always be performed to much greater advantage at the mines, from the fact that it obviates all unnecessary transportation of superfluous weight. Yet, in view of all this importation of pig metal by the Pittsburgh factories, she is enabled, by the extreme cheapness and excellence of her fuel, to send back her manufactured bar iron and casting, fully competing in cheapness with the local mills and foundries in the very regions from which she draws her supplies, if we except the East. Unquestionably the present cost of manufacturing would be greatly reduced by her operators were they enabled to dig their supplies of ore nearer home, and which great desideratum she has now every prospect of speedily realizing.

Indeed from discoveries recently made, there are slumbering millions scattered all over that region of Pennsylvania, simply awaiting the strong arm and skilful hand of enterprise to pluck the ripened fruit.

Without entering upon the comparative cost of the production of iron in Pittsburgh—its peculiar qualities, &c.—a subject which in itself might well nigh transcend the limits of a single article, I will simply sum up the present with a hasty glance at the various classes of her iron works, without pretending to review their gradual development through the last quarter of a century, and the unrivalled success which has marked their progress.

Pittsburgh has now in operation—or at least will have when cool weather commences—twenty-five iron and steel rolling mills, owned by twenty firms, who own in connection with these, 262 puddling furnaces, 165 heating furnaces, 448 nail, spike, and rivet machines, and 16 converting furnaces, and consume, in the aggregate, pig iron, blooms, coke, coal, clay, oil, grease, &c., amounting to $6,243,820 60 annually.

Adding to this annual expense the wages of 4,623 hands, which is estimated at $2,366,020, or an average of $511 79 a year to each laborer, together with the capital in the ground, buildings, and machinery employed in the prosecution of the business, which is valued at $3,280,000, and we have the aggregate expense attending the carrying on of the 52 mills, which amounts to the enormous sum of $11,889,840 60, or eleven millions eight hundred and eighty-nine thousand eight hundred and forty dollars and sixty cents.

That the above is an inside estimate may be inferred from the fact that a single one of their number—located at Brownstown, some five miles from the centre of Pittsburgh proper, and which I had the pleasure of examining during my recent visit to that city—owned and conducted by Messrs. Jones &

Lauth, stated, in answer to my inquiries, that they gave uniform employment to three hundred hands, and that two millions of dollars a year were required to carry on the business of the establishment.

That these extensive investments are made to *pay* handsomely may also be inferred from the rapidity with which these operators have leaped from moderate circumstances into princely affluence, with scarcely an exception. In addition to the rolling mills, the foundry business here is also very extensive. Sixteen of the latter are now in successful operation, with a yearly capacity in the aggregate of 44,300 tons, and from which are daily emerging articles of almost every description and bulk, from a 15,000 pound cannon to instruments no larger than a lady's bodkin.

IRON MINING AT LAKE SUPERIOR.

The Lake Superior Journal says:

The Pioneer Company are making good headway with their opening work, and we understand have some twenty-five feet of their back wall up, and about 1000 cords of wood cut, ready for coaling, besides buildings and out buildings for their men and teams. The furnace is to be constructed on a side hill, and the back wall of which we speak, is against the bank, or excavation.

The receipts from the mines show a little advance in amount of ore brought down, and if no untoward accident occurs it will be still more increased, next week. The Cleveland Co., are fitting up a portion of their cars to run on the locomotive road, from Duncan's steam mill, nine miles from the dock, and will commence the experiment to-day. The cars will be drawn to this place, on the strap rail, by horses, and then switched off on the T rail; this will enable them to run two trains per diem, instead of one, which is very essential, as several vessels are now waiting for freight. The only difficulty apparently attending this arrangement is the light build of the horse cars, rendering them almost unsafe for the rapid motion of the locomotive; yet with careful running they may hold out until the heavier cars, which are here, can be put together. We have not much fear as to the result of this experiment with the light cars, as Mr. Donkersly, who has charge of the running of the train, is a very careful and experienced man. We shall probably be able to give the result next week.

The receipts on the dock, for the week ending July 24th, are per

Cleveland I. M. Co.	500 gross tons.
Sharon Iron Co.	500 " "
Total	1000 " "
Shipments during the same time.	
Sharon Iron Co.	1193 tons,
Cleveland I. M. Co.	1827 "
Total for the week	3020 "

Although most of this ore is shipped to Cleveland, it should be remembered it is mostly again shipped to the interior of Ohio and Pennsylvania.

IRON IN CALIFORNIA.

It would really seem that there is no limit to the mineral resources of this highly favored region, which but a very few years ago was an obscure province of Mexico, valuable only for its exports of dried hides.

By the last steamer we received a letter from Jos. P. Paxon, of San Francisco, in which he informs us that within a few days there has been discovered a large bed of iron ore in Placer county, and the specimens which he had examined seemed to be almost solid iron.

"It lies," says the *Press*, "in vast quantities upon the surface of the earth, and an immense amount of it can be obtained with no further trouble than picking it up and loading it into wagons. It has been tested and found to contain *eighty-three* per cent of pure iron. Mr. Lovell, (of Auburn,) the

owner, has commenced operations upon it. He passed through town on Thursday last with two wagon loads of the ore destined for shipment to San Francisco. We understand that he has contracted for the delivery of a large amount of it to a San Francisco foundry. This is indeed a most important accession to the list of our mineral resources; and should the railroad be extended to this place, so as to reduce the present high rates of transportation, Mr. Lovell's iron mine will be more valuable than any gold mine in the country."

The same paper asserts that Placer county is unequalled by any other in the State, in the extent of her mining districts, the richness of her mines, or the variety of her minerals. In Green Valley, copper is found in abundance and in great purity all over the hill sides.

If this iron ore can be worked economically, it will be a most important addition to the mineral wealth of the Golden State.—*Sci. American.*

STATISTICS OF IRON AND COPPER.

A report made and published by authority of the British Parliament, exhibits some interesting statistics relative to the production of iron and copper in all countries. We are indebted to the Washington *Union* for the following condensation of this exceedingly able and interesting report:—

The total quantity of pig iron produced, it appears, is 6,000,000 tons, viz.: Great Britain, 3,000,000 tons; France 750,000 tons; United States, 750,000 tons; Prussia, 300,000 tons; Austria, 250,000 tons; Belgium, 200,000 tons; Russia, 200,000 tons; Sweden, 150,000 tons; various States of Germany, 100,000 tons; other countries, 300,000 tons. A comparison of the countries which chiefly produce iron for the last twenty years, shows that Great Britain increased in 1850, 244 per cent.; the United States, in 1850, 171 per cent.; France, in 1846, 141 per cent.; Russia, in 1849, 1851, 20 per cent.; German Customs Union, (Zollverein,) in 1850, 60 per cent.; Austria, in 1850, 140 per cent.; Norway, in 1841, 1845, 62 per cent. Much valuable information is spread before the British Parliament in reference to the causes which have retarded the development of this branch of industry throughout the world. The protective duties on iron in France are ably discussed, and the causes of the absence of progress in the iron production of that country are thus classified: 1. the revolution of 1848; 2, want of railroads; 3, apathy among manufacturers; 4, unfavorable sites formerly chosen for works; 5, the tenure of property and the system of carrying on works by paid managers; 6, the interference of government with the affairs of the miner; 7, the ancient custom of using charcoal and wood, and 8, the absence of banking accommodation.

In respect to Prussia, it appears from a critical review of the metal producing interests of that country, that the restraining influence of the government is injuriously felt. Little or no competition exists either for labor or for orders, for a close combination of the whole trade, both in Rhenish Prussia and in Silesia, has been established.

The Swedish Government has always manifested a great interest in the development of this important branch of its metal industry. It has lately abolished the feudal rights and privileges of the nobility, who had enjoyed previously certain preferences as iron masters, and the iron trade was opened to a free market. Until very lately the exportation of pig iron was prohibited in order to encourage the manufacture of bar iron; in Sweden this law is now repealed, and pig iron can be either exported or imported by payment of a duty of $3 per ton. In Russia the manufacture of iron has made the greatest progress. Notwithstanding extensive protection, as no iron can be imported by sea, and the duty by land on pig iron is 600 per cent., the production of iron in Russia is only 8.7 pounds, and the consumption 9.7 pounds Russ. per inhabitant; whereas in England the production is 231, and the consumption 133.4 pounds Russ. per inhabitant. In Belgium the production of

iron has increased considerably. In the United States it is also on the increase, but with us the consumption of iron per capita of our population is greater even than in England. In 1845, the consumption was estimated at 1,324,772 tons, of which 805,000 tons was of domestic production, and 500,000 tons imported from Great Britain. With regard to steel, the manufacture of cast and shear steel in Great Britain, in 1856, was estimated at 680,000 tons. In France the consumption during eighteen years has been four-fifths of that consumed in Great Britain. The iron used in France in 1835 was a little over a third of that used in England; in eighteen years it increased to nearly half the quantity worked up in Great Britain.

We have carefully retained and laboriously condensed the leading facts in this very able and interesting report, knowing that there is no subject in which our citizens in every section of the country feel a deeper interest. Such reports are the very life and spirit of British commercial enterprise; they supply it daily aliment and furnish it with snowy wings to penetrate even the most remote and obscure recesses of the globe. We trust that when the law of last Congress authorizing the appointment of two additional clerks to be devoted exclusively to the preparation of the requisite material to enable the Secretary of State to transmit an annual report on foreign commercial changes and regulations, as required by an act in 1842, to which the act referred to was merely supplemental and remedial, shall be in full force, we shall have the pleasure often of presenting to our commercial, manufacturing and producing classes such reports as the one now before us.

The total value of copper raised in 1854, was $41,659,020. The production, consumption, and reduction of copper from the ore in different countries for 1846, are given as follows: In Great Britain copper annually raised amounts to 15,800 tons; consumption, 10,600 tons; copper annually smelted, 28,600 tons. France raised (in 1846) 30 tons, consumed 9,200 tons, smelted 700 tons. Russia raised 3,900 tons, consumed 2,000 tons, smelted 3,900 tons. Austria raised 4,500 tons, consumed 2,600 tons, smelted 4,500 tons. Sweden and Norway raised 2,200 tons, consumed 400 tons, smelted 2,100 tons. Zollverein raised 1,500 tons, consumed 4,500 tons, smelted 1,500 tons. Turkey in Europe, and Mediterranean States raised 3,100 tons, consumed 6,600 tons, and smelted 2,800 tons. America, including Cuba and Chili, raised 16,600 tons, consumed 6,100 tons, smelted 5,900 tons. Oceanica, Australia, New Zealand and Asia, raised 2,400 tons, consumed 3,300 tons. Japan raised 2,400 tons, consumed 1,200 tons, smelted 2,400 tons. Total raised 52,400 tons, consumed 52,400 tons; and smelted annually 52,400 tons.

Under the operation of French navigation laws the French smelter is most disadvantageously situated, as he can only receive his ore at the low duty when carried in the ships belonging to his own country, the probability being that only one out of twelve vessels sailing from any particular port is a French vessel, while the total tonnage of French vessels is only one-eighteenth of the whole mercantile navy afloat.

It is true we have had altogether five annual reports on foreign commercial changes and regulations from the State Department: one by Mr. Webster in 1842, one by Mr. Upshur in 1843, and a third by Mr. Calhoun in 1844, under the original act of 1842; and two others, one in 1855, the other in 1856, by Mr. Marcy, under the same act amended in 1855, the amendment merely providing the requisite clerical force (a superintendent of statistics and an assistant) to enable the Secretary of State to give effect to the act of 1842; but, doubtless, chiefly for the following reason, given in a note accompanying the report of 1856—viz: "The pressure on this office of duties of prior date has precluded the preparations of part one of this report as a digest, as was designed, and as seems contemplated by the act of 1842"—these five annual reports are merely the heralds of what we may hereafter look for.

Our consular corps is composed of as much intelligence, general inform a on, and, at the more prominent consulates especially, of as high an order o

general qualifications, as the consular representatives of any nation on the earth. The able head of the State Department, and the efficient and accomplished Assistant Secretary, are exerting every proper effort to abate, as far as can be done consistently with the demands of the public service in that department, "the pressure of duties of prior date;" and this having been entirely accomplished, there is no reason to fear that we shall be in the rear of Great Britain, or of any country, in the character, scope, and general information of our annual commercial reports from the Department of State.

IMPROVED FURNACES.

Mr. C. William Siemen's new arrangement of furnaces, is particularly applicable where great heat is required, the object being to utilize a large proportion of the heat which is commonly allowed to escape into the chimney. The products of combustion are made to pass through a mass of perforated brickwork termed a "regenerator, which presents an extended heat-retaining surface; the portion of the brickwork which is first acted upon is heated to the highest degree, and the succeeding portions to a less and less degree, so that the products of combustion are thoroughly deprived of their heat before they reach the chimney. The direction of the air current is reversed at intervals of about an hour, by means of a valve in the bottom of the chimney, and the heat previously deposited in the first regenerator is taken up by the fresh air, which reaches the place of combustion in a highly heated condition, and produces a flame of much greater intensity than could have been obtained by means of cold atmospheric air. The intense heat of the flame so produced is communicated to the second regenerator in the same manner as before described, the products of combustion reaching the chimney comparatively cool. By the repetition of this process of reversing the direction of the draught through the furnace, an unlimited degree of temperature may be obtained, and the saving effected is in proportion to the increased degree of heat required. One furnace upon this principle has been working for the last three months at Messrs. Marriott and Atkinson's works, Sheffield, for heating ingots of steel and iron; it has so far worked most satisfactorily, and realized a saving of 79 per cent. of fuel, over the ordinary heating furnace, in doing the same amount of work. The regenerative principle has lately been applied to other purposes. A puddling furnace was put into operation last week at Bolton; its results in the saving of fuel are the same as in the case at Sheffield, and it is also expected to exercise a very favorable influence upon the purity of the iron produced. The new furnace effectually prevents the emission of smoke from the slag. The application of this regenerative principle to furnaces was suggested by Mr. Frederick Siemens, brother to the writer of the paper, and has been carried out by the two brothers conjointly. Mr. Atkinson said the result of his experiments with the new furnace was, that during six days, commencing with the 13th inst., it consumed 1 ton 10 cwts. while the consumption by the old furnace was 7 tons, each furnace doing the same kind of work. With the new furnace steel had been melted with a consumption of less than 1 ton of coal. He considered that the new furnace was admirably adapted for every heating operation, and that its results in the saving of fuel were gigantic. The furnace was also calculated to last three times as long as an ordinary one Mr. Cochrane, of Dudley, remarked that it would be a great boon if the results of the working of this furnace for puddling iron could be ascertained and furnished to the institution by Mr. Siemens on some future occasion.

JOURNAL OF GOLD MINING OPERATIONS.

IMPROVEMENTS IN OPERATING UPON METALLIFEROUS ORES, &c.

In resuming the subject of Mr. Bursill's inventions, it would appear that he was not only the first to employ the use of an alkaline ley, also of sulphuric acid for the treatment of matrix ores in the large way, of the hydrostatic amalgamator, &c. (for his patent dates as far back as Feb. 12, 1853, and there can be no doubt, therefore, of priority), but that at a time when several of our correspondents were disputing as to the probable existence of gold in a mineralised state, Mr. Bursill had not only become aware that it might be so, but had actually patented the means whereby gold might be obtained from minerals when existing in that state – either by galvanic or other agency.

With the exception, perhaps, of some vague hints to such effect, Mr. Calvert was, if we remember, the first to call public attention to this subject in our Journal, by some remarks which we published July 1, 1854, and which were followed by observations from Mr. Low, Jan. 27, 1855; also from Mr. Harris, Feb. 3, 1855; Mr. Evan Hopkins, Feb. 10, 1855; Mr. Walter Byers; our talented correspondent, Mr. Mitchell; and several other gentlemen, all of them having a similar tendency. Dr. Percy, also, of the Geological School, Jermyn-street, was about this time reported to have made the discovery that gold existed even in sea-water.

On referring, however, to Mr. Bursill's patent for "improvements in operating upon metalliferous ores and other minerals, and upon 'slags' and 'sweep,' in order to facilitate the separation and recovery of the metals and other products, also in machinery or apparatus for effecting such improvements, which is, in part, applicable to other purposes, sealed 30th of May, 1854, and dated 19th of January, 1854, we find it to run as follows:—

"When I have reason to suspect the existence of the salts of gold or of silver, whether in the ore, mineral, or sweep, I do not simply amalgamate, but I add to the ore, whilst it is in the act of pulverization or of grinding, as much water only, or as much dilute acid or other medium, as shall put it under favorable conditions for the galvanic influence; and I then throw down the gold or silver in the metallic state while grinding, either by the grinding machine itself, or by appendages attached thereto, as in the form of rotating scrapers, rakes, or plates made of iron, copper, or zinc, as may be required; or I cause the ore to be ground in a solution of the proto-nitrate of mercury, or of the proto-sulphate of iron, or in a heated solution of carbonate of soda or of oxalic acid, or with such re-agents as are best calculated to precipitate the gold or silver as nearly as possible in a metallic state, and, therefore, favorable to the subsequent action of the metallic mercury when used for the purpose of amalgamation; or having first caused the ore to be partially broken up by cold dry process, effected by machinery hereinafter described, I evaporate to dryness and grind, and amalgamate upon a hot plate, by other machinery also hereinafter described, passing the tailings through the patent amalgamator or separator, a description of which will be found in the specification of a patent granted to me by Her Most Gracious Majesty, Queen Victoria, for improvements," &c.

In other words, Mr. Bursill having first induced conditions that are favorable to electrical or galvanic action, converts the crushing-machine itself, when desirable, into a huge voltaic battery, causing the gold to be thrown down in the metallic state, as from a solution of the alkaline sulphuret for example, during the act of trituration or reduction in size, with which exception his process somewhat resembles a plan afterwards brought forward by M. Becquerel, a description of which was published in our Journal Aug. 19, 1854.

It is true that any gold thrown down by such means must at all times be at the expense—weight for weight—of so much iron, &c.; but the process is

simple, and will be readily understood by our scientific readers; and who is there would object to the exchange of a ton of iron or of zinc, under such circumstances, for a ton either of silver or of gold?

The specification also relates to operations upon ores in which the gold or silver contained, although in the metallic state, is in particles so extremely minute as to be scarcely, if at all, discernible by the naked eye.

We have ourself seen specimens in which the gold, though visible, was as fine as the dust upon a moth's wing, and, therefore, very difficult to secure; and any method for effecting this object by amalgamation must be extremely valuable.

When the auriferous ore, argentiferous ore, slag, sweep, or tailings, contains gold or silver in the metallic state, but in such minute particles as not to be visible sometimes to the naked eye, he causes them to be pulverized, ground, or reground to an impalpable powder, not with metallic mercury alone, or with metallic mercury and water only, as practised heretofore, but with a solution of mercury, or with a solution of some one or other of the salts of mercury that are readily soluble in water, and either with or without the addition of metallic mercury; the advantage being that the ore so ground may be readily brought in contact with, and thoroughly moistened by, such a solution, and far more easily than with metallic mercury, the specific gravity of which is so great as to give it a tendency to remain at the bottom, while the minute portions of gold, so wetted, no sooner come in contact with the machinery for grinding, or with the apparatus used in connection therewith, and which should be of iron or other material suitable for producing such effect, than they become coated with running mercury that is precipitated from the solution by galvanic agency, it being an established and delicate test of the presence of mercury that if a drop only of a strong solution of corrosive sublimate for example be placed upon a gold coin or ring, the simple contact of gold with iron, as with the point of a penknife (that is, through the solution), causes the mercury to be thrown down in a bright silvery stain, and the minute specks of gold, on becoming so coated, readily adhere to, or amalgamate with, any metallic mercury to which they may be subsequently exposed.

The invention further relates to the methods for smelting, and for the roasting of arsenical ores, sulphurets, &c.

His improvements in operations, either during or immediately subsequent to smelting, consist in the employment for the purpose of fluxing the ore, of either potash or soda in excess, or so proportioned as to lead to the formation of a slag that is soluble in water, or with less difficulty than that commonly made in the larger operations for the smelting of gold and silver ores (still less of other metals), the use of potash and soda as fluxes having been hitherto in a great measure precluded on account of their expense.

This slag he causes to be precipitated into any suitable fluid from which the potash or soda may be afterwards recoverable by first throwing down any contained silica, alumina, or other impurities; then drawing off the supernatant liquor, and evaporating in the ordinary manner.

The silica, &c., he either throws down by carbonic acid gas (the advantage of which is described in a former patent, when used for purifying a ley) or he causes it to be precipitated by aid of chalk or of lime, and so obtains products that are useful as manures, &c.

This plan is identical, or very nearly so, as our readers will not fail to perceive, with that with which the Melbourne papers have been so lately occupied, and extracts from which, headed "Solution of Quartz," appeared in our own columns only a month ago, as well as in those of the *Times*. The merit of the discovery having been attributed by our countrymen in Australia, it seems, to the Count Dembinsky; but Mr. Bursill is undoubtedly the original projector of this plan, and it should be known in future as Bursill's process, having been patented by him as far back as January, 1854.

Mr. Bursill goes further than the Count (who speaks only of the employ-

ment of soda,) since, in addition to either soda or potash, he employs, when readily procurable, certain varieties either of felspar or other minerals, containing, naturally, so large a percentage of potash or soda as to give to them a tendency to melt *per se*—that is, when heat is applied; and this combination of materials, he also uses in such proportions for fluxing the ore as shall have the effect of producing a readily soluble slag, the advantage being that not only the potash or soda originally introduced, but that of the mineral used in conjunction therewith, is also recoverable by such means, rendering the operation of smelting, with the use of the more valuable description of fluxes, comparatively inexpensive, which is the object he desires to attain.

Potash supplied from the ashes of wood employed for fuel (as must frequently be the case in Australia and California) may, under this method of operation it is considered, be advantageously employed as a flux, and so rendered subservient to the process of smelting, not merely to the extent of compensating for any waste incurred, but of furnishing a large amount of potash for sale.

For the roasting of arsenical ores, sulphurets, &c., independent of the use of reverberatory furnaces, he occasionally operates by aid of close vessels or retorts conducting the volatile products through a pipe or pipes, into a vessel or vessels filled with a fluid suitable for promoting condensation, and which solution or fluid (or it may be gas) is, of course, adapted to the particular circumstances of the case, according to the description of product that is required to be obtained.

The vessel containing the ore or mineral that is to be wholly or in part sublimed, may either be set immediately over the furnace, or it may be apart therefrom, in either of which cases, however, he exposes the mineral to be operated upon under suitable arrangements, as at a particular stage of the roasting, for example; or as under pressure, when advisable, to the effects of a blast or current of atmospheric air previously heated to the temperature required for effecting volatilization; and it is to the facilities afforded by this method of operation for varying the temperature of the air so applied, and the force of which is under control, or can be checked at any moment, agreeably to that at which its oxygen is known to combine with any given substance in the ore (in addition to the various solutions or fluids, &c., that may be employed for condensation), that the advantage of this system may be attributed of affording, as it does, so great a range for the manufacture of different products.

He does not confine himself to the use of the atmospheric air, but sometimes employs other gases calculated to effect deoxidization if required.

Specific arrangements are described for preventing the formation of a sulphide or matte, amongst which is the use of properly selected pumice, broken into moderately small pieces, and which, from its porosity and lightness, is considered to possess peculiar advantages, one of which is, that it can easily be separated from the metallic oxides when they are thrown into the water, previous to effecting mercurial amalgamation as it floats on the surface, and can, therefore, be collected and used over again. Arrangements are also described for promoting the effects derived to be produced within the chambers for condensation as well as for bringing the ore, or mineral within the roasting vessel, into intimate contact with the heated air, and for regulating the escape of the latter when working under pressure.—*London Mining Journal.*

NEW GOLD FIELDS IN VENEZUELA.

By the last advices from the West Indies, some important information is received respecting the lately discovered gold fields in Venezuela. It is settled beyond question that plenty of gold is being found in Tupuquen, on the Orinoco, (the El Dorado of Sir Walter Raleigh.) On June 7, there was about 412 persons engaged in digging; 105 houses had been erected, and large sums of money had been amassed by such as could work. Some nuggets of pure gold,

free from quartz, had been obtained, weighing about 1 oz. each. Gold to the amount of from 12 to 14 ozs. per day, and requiring no washing, was stated to be found. The mines are seven by fourteen miles in extent, and provisions were cheaper than at Trinidad. There was not a single noise or riot at the mines, and the people were healthy. In consequence of the wet season, extensive operations cannot commence until October.

WEALTH OF THE GOLD AND SILVER MINES OF MEXICO.

According to the official Custom House report the exports of the precious metals from the port of Vera Cruz, for the first five months of the present year were as follows, in round numbers:

	Gold coin.	Silver coin.	Do. manf.	Total value.
January	$55,370	$2,389,227	—	$2,444,597
February	17,607	366,775	371	384,133
March	17,956	654,130	454	672,540
April	54,799	1,657 009	1,088	1,712,896
May	16,149	546,881	130	563,160
Total	$161,281	$5,614,003	$2,042	$5,777,326

As to the exports of the last two months, we have at hand no means of ascertaining the exact amount. They were, however, undoubtedly large; during the month of June larger, probably, than any month of the year, certainly not less than two millions. Adding this to the above, we have a sum total for the exports from Vera Cruz alone, during the first half of the present year, of $7,777,826. Those from Tampico, Acapulco, Mazatlan, &c., would swell the amount to not less than ten millions of dollars.

In connection with this subject, it would be curious to inquire what has been the amount of precious metals realized from the Mexican mines since their first discovery, or even since the conquest by the Spaniards, now going on three centuries and a half. It would be almost fabulous. For the period of twenty-seven years, from 1825, when the present form of government was adopted, to 1851, during which time Senor Lerdo de Tejada has furnished us reliable statistics, the average annual exports were $9,481,042. We add his figures—the fluctuations are chiefly attributable to the unsettled political state of the country:

1825	$3,702,447	1839	$11,625,141
1826	5,847,795	1840	6,402,135
1827	9,669.428	1841	11,661.491
1828	12,387,288	1842	8,511,556
1829	12,022,312	1843	10,645,683
1830	10,534 974	1844	11,661,296
1831	7,280,803	1845	11,330 901
1832	14,160.146	1846	9,687,829
1833	13,537,759	1847	888,190
1834	8,062,213	1848	10,994,738
1835	12,705,471	1849	12,166,806
1836	8,471,826	1850	8,603,081
1837	4,459,745		
Total			$237,026,061

Add to the exports of the last seven years, estimated on the same average, and we have a sum total of more than three hundred millions of dollars, since the foundation of the republic, now alas! bankrupt.

But these, it will be borne in mind, are but the legally ascertained exports from the country alone, and but a small portion of the actual products of all the mines, which are set down by the best writers at upwards of thirty-five millions annually; and not unreasonably, when we consider the vast amount of unproductive wealth in the previous metals, accumulated in the country. Assuming this as an average, and the total products of the Mexican mines, since the conquest of Cortes, would amount to not less than $11,760,000,000, a sum in comparison with which any of the incredible stories told of the wealth of the ancient Aztecs, seems probable.

GOLD QUARTZ CRUSHING IN SIBERIA.

The gold mines of Siberia employ 40,000 workmen, producing about 1,500 pounds (or 24,564 kilogrammes) of gold, valued at 73,692,000 fr. The processes in use for working them are, however, very costly, and the Government mines do not by any means produce the profits which might be expected. It is the same with the private workings. In some parts of Siberia many mines have been given up, because the yield would not cover the expenses. This state of things has for some time past occupied the attention of the Government, but until now no remedy could be found. Lately, however, a Russian subject, who has been for several years in California, has invented a machine which will so simplify the plan of working hitherto adopted, that the 40,000 workmen may, instead of producing 1,500 pounds of gold, give 3,000. The works which have been abandoned may also be resumed, with the certainty of great profits. These new machines are to come into operation in the course of the present year.

JOURNAL OF COPPER MINING OPERATIONS.

GARDEN CITY MINE.

Mr. Samuel W. Hill has made a report on the Garden City Mine from which we extract as follows:

"The first work performed at the mine, was about the middle of July 1856, since which time an adit gallery has been excavated in the west vein, 142 feet in length, and one in the earth and rock in the east vein, 148 feet easterly from the west vein, and in the ash and scoriaceous cupriferous bed of rock, a gallery has been opened 29 feet. In this bed, on the west side, 32 1-2 cubic fathoms have been excavated. Westerly from the east vein, and in the cupriferous rock, a gallery has been opened 42 feet, and 30 cubic fathoms excavated. An air shaft in the west vein has been sunk 12 feet in the rock.

"The amount of rock excavated in the cupriferous bed, and along the veins in that bed is 81 cubic fathoms. This will give, of good stamp stuff, 1000 tons.

"Two dwelling houses have been erected, one of which is now occupied by the agent; the other is now being finished and will be ready for use in a few days. They are estimated to be worth $550. Some labor has been expended at clearing up the woods about the surface of the mine, and in constructing a road towards the mouth of Eagle River.

"This comprises the amount of work performed to the first of this month. The expenses, to this date, are $4101.83. In this amount is included all expenses for materials, tools, and labor, and hence, all expenses of the company. Drafts have been made on Treasurer to the amount of $2950; and $300 have been received at the mine of S. W. Hill, making $3250. The liabilities amount to $851.83; of this amount there is due the employers at the mine $334.47, and to Messrs. H. F. Leopold & Brother, on whom the agent's orders are made for the payment of employers, $517.36.

"The amount of personal property at the mine will not exceed $200.

"It will be seen, that nearly the whole expenses, thus far made, have been confined to the opening of the mine, and excavating stamp stuff from the cupriferous bed. The object in thus operating the mine, has been to determine, as early as possible, the propriety of erecting stamping machinery this season.

"There has been but little work done in the veins—no more than has been necessary to open adit galleries to the cupriferous bed. In the western vein a course of copper has been met with, which promises to produce some heavy

copper below the adit. The other vein is a very large one, and when opened has produced coppor. These veins should be worked. They are the *only* and *true* repositories of mass copper, which will be found in the location. Whenever any of the veins of the country, which have been worked, traverse the ash and scoriaceous rock, they have invariably been found to contain heavy branches of mass copper in that rock, or in the rock adjacent thereto. I shall urge upon you the importance of working a force, hereafter, in the veins.

"The mine is now in want of good and efficient stamping machinery, and such should be purchased and erected this season. My letters to you during the past winter, will have given information of the capacity and kind of a mill.

"So far as the work has gone, it has been found as rich in copper, as I have expected it would be; but cautiousness and due regard for my position, induces me to refrain from holding out inducements to you, of its value, beyond where I am able to see and know."

EVERGREEN BLUFF MINE.

On the eastern extremity of the Evergreen Bluff is the Evergreen Bluff Mine. The mineral tract is the N. E. 1-4 of sec. 6, town 50 N. Range 38 W., but they have upwards of 500 acres of land. Some exploration has been made on quite a number of veins, which shows that the copper in the hill is by no means confined to a single lode, but considerable mine work has been done on Evergreen main vein. A drift on the course has been made for near 400 feet—shaft sunk to it from the surface and continued to a second level. The second level is driven near 250 feet and connected with the upper level, on the west by a winze. This arrangement secures ventilation throughout the mine, and has exposed considerable ground for stoping. The vein yields a large proportion of mass copper. In April last they had 23 masses on hand, and 33 barrels. They have also a large amount of rich stamp work which will add materially to the value of their mineral product, whenever arrangements are made for working it up. The copper has been well cleaned. Last year's product yielded 68 1-2 per cent., without burning, besides the yield of the slag. They have adopted the plan of burning the stuff this year, and will, of course, be able to make it much cleaner.

The total amount assessed is $1.25 per share This, and the amount of copper sold has furnished funds sufficient to make the present improvement of the mine, and to pay the working expenses until next winter. At that time they will probably have raised from 40 to 50 tons of copper, which will be sufficient to drive on the works for the greater part of a year, without burdening the stockholders by another assessment. And meanwhile there is good prospect that the new openings will make the mine self-sustaining. There has been prudence and economy in the management of the mine thus far, and the work has proved the location to be of great value, and there is at present every indication that it may be worked on a large scale with abundant profit.

The conglomerate belt and lode which shows at the western end of the bluff on the Nebraska location has not been disclosed upon this. But they have opened on it upon the Ridge property adjoining, and only a few rods from the boundary line of the Evergreen. The next vein to the north of this is called "Ancient Diggings vein"—from the fact that its course is very distinctly marked by ancient pits. It is regarded as a valuable feature in the property. Its outcrop is quite low in the bluff. The next vein on the north appears on the surface bearing copper, and was pierced by a cross cut which was driven for exploration from the south side of the hill. Its value is yet unproved.

The next vein was also intersected by the cross cut above mentioned, at a point about 90 feet below the surface and summit of the bluff. It is peculiar on account of its great underlay—differing at the point of intersection by the

cross cut less than 20° from the horizon. Mr. Roberts, the agent, thinks it to be the vein of the Mass mine, upon which the principal work has been done on the latter location. Next to this comes the Evergreen main vein, upon which are the works that we have described. Another unexplored vein lies to the north of this, and then comes the Bohemian, and lastly the Ridge veins. The latter, however, merely crosses the corner of the location, and the Evergreen has no valuable extent of it. Thus, they have six, and with the conglomerate, seven parallel veins, upon this location of sufficient length to work.—*Miner.*

LAKE SUPERIOR COPPER REGION.

We have endeavored for more than a year past to obtain the exact figures relative to the shipment of copper, not only of the aggregate amount, but also the amount shipped from each mine, but have not as yet succeeded entirely to our satisfaction, owing to the disinclination of mine agents and officers of boats. The only place these figures, which are valuable, can be obtained with facility, is at the canal, through which it must all pass, and a little accommodation on the part of the clerks of boats will make the matter easy to obtain. We give below a statement furnished by the obliging clerk of the canal office, Mr. Alvin Burt, which, with one or two exceptions, is just the thing. Mr. B., however, thinks he will be able to give the names of mines entirely hereafter:

SAULT STE. MARIE, July 24th, 1857.

Editor Lake Superior Journal:

The whole number of steamboats and sail vessels that have passed through the St. Mary's Falls Ship Canal since July 1st, are as follows: Steamboats 14, propellers 15, and sail vessels 38. Boats that have passed, bound down, loaded with copper:

July 1st, propeller Mineral Rock:

Mines.	*Tons.*	*Mines.*	*Tons.*
Minnesota	124	Portage	69
Rockland	14	Quincy	11
National	7		
Cliff	133	Total	408
North America	50		

July 4th, schooner A. Medbury:

(Mines not reported,)	186

July 7th, steamer Illinois:

Minnesota	52	National	8
Rockland	6	Connecticut	17
Norwich	5	Huron	6
Nebraska	3	Copper Falls	16
Ridge	8		
Adventure	15	Total	145
Arctic	12		

July 11th, propeller Iron City:

(Mines not reported,)	200

July 11th, propeller Manhattan:

Minnesota	88½	Norwich	5
Rockland	5		
North American	59	Total	157½

July 15th, schooner Seaman:

Minnesota	120
Rockland	10
Total	130

July 17th, steamer Illinois:

	Tons.
Minnesota	80

July 20th, steamer North Star:

(Mines not reported,)	10

July 21st, propeller Mineral Rock:

Mines.	*Tons.*	*Lbs.*	*Mines.*	*Tons.*	*Lbs.*
Cliff	241	1,445	National	5	1,742
Copper Falls	29	313	Adventure	10	156
Pewabic	21	303	Arctic	4	1,679
Isle Royale	15	1,591			
Huron	2	701	Total	334	531
Ridge	5	400			

July 24th, Schooner G. W. Ford:

Minnesota	196
Total tons	1,746 and 531 lbs.

COPPER IN THE SEA.

Some five years ago, two French chemists demonstrated that the ocean contained a notable portion of silver. Recently these and other philosophers have again been at work upon the same subject; following it up, however, much closer, they now tell us that, calculating the whole ocean, it cannot contain less than two millions of tons of silver in solution. The truth of this statement is verified by experiments tried at various parts of the world—one more famous than the rest by Mr. Field, an English chemist, who lives at Coquimbo, in Chili. The water he analyzed was taken from the Pacific Ocean, and afforded the same result as that which the French chemist obtained from water taken off St. Malo, France, in the English Channel. That the ocean should contain minute portions of every substance of the globe that is soluble in saline water is not surprising; therefore we are, in a measure, prepared for the further discovery that the "old greybeard," ocean, contains also an enormous quantity of copper—a fact recently proved in the laboratory of our London contributor, Mr. Septimus Piesse. The beautiful blue color of portions of the Mediterranean Sea is due, he says, to an ammoniacal salt of copper, while the greenness of other seas is owing to the chloride of copper. The method of extracting silver from the sea is one of simple affinity. Granulated copper being suspended in the "briny waves," any silver salt that is contained therein is decomposed, a portion of the copper is dissolved, and the silver is precipitated thereon, from which it is afterwards parted by the usual means adopted in every laboratory. By a happy analogy, Mr. Piesse separated copper from the sea by the same process. His experiments were performed between the ports of Marseilles, on the French Mediterranean coast, and Nice, in Sardinia. A bag of nails and scrap iron was suspended at the side of the steamer which plies between these places, and after the first voyage (about twelve hours), copper was indicated to be present on the iron. Four separate voyages, however, were made before the bag of iron was removed to the laboratory; then the quantity of copper was found to be so great that much surprise was shown that the presence of this metal had not been previously discovered, especially when the action of sea water on ships' bottoms has long been known.

Mr. Piesse is continuing his experiments, and we shall not fail to notice what is going on in his laboratory, concerning this singular and wonderful discovery.

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

SONORA SILVER MINING COMPANY.

This company was organized in Cincinnati in March 1856, under the name of the "Sonora exploring and Mining Company," previously noticed on page 586, vol. VIII. of this magazine. We now add the following particulars relative to its prospects:—

The object proposed by its projectors was to send a party to the northern portion of Sonora, which came into our possession by the Gadsden purchase, to search out and obtain ownership to some of the most valuable of the old Spanish mines, that were abandoned at the period of the famous Mexican Apache War. These, according to the tradition of the Mexicans, were within our boundaries, and afforded a legitimate object of pursuit to citizens of the United States. In pursuance of this design, the company, in April, 1856, sent Col. C. D. Poston, a gentleman who, in company with a scientific geologist, had already spent several years of time and a small fortune in investigating the mineral resources of the territory, with a party fully armed and equipped for any emergency. After careful explorations in the whole territory, the head-quarters of the company were established at Tubac, as the centre around which its operations would be performed. The explorations of the company have resulted in the acquisition of over *eighty* veins of silver ore, including over thirty mines that had been worked in previous times, and twenty thousand acres of land, which is valuable as well for its agricultural as its mineral resources. The number of mines now owned by the company, and all located within sixteen miles of Tubac, is as follows:

At the Santa Rita Mountains, including the old Mines of Salero and Ojero	24
On the Ranche of La Aribac, usually called Arivaca, old mines	32
At the Cerro Colorado Mountains, including the Heintzelman Mine	29
At the San Coyetano Mountains	2
Number of mines	80

In addition to the above on the Arivaca Ranche, which was acquired by purchase, and contains over seventeen thousand acres of land, with permanent water and abundance of wood and grass, there are known to exist many veins which have not yet been opened, but the ownership of which belongs to this company.

Value of the mines.—It is almost impossible to give an adequate idea of the value of the mines already acquired by this company, because they are as yet comparatively undeveloped, and the full extent of their richness unknown. It is a conceded fact, however, that the characteristics of the mines of Southern Mexico, which have given the nobility of that country their immense landed estates, were rather the abundance than the richness of their ores. That in many instances these mines were worked to a depth of thousands of feet, and still repaid their owners with immense fortunes every year. Ward states that Zambrano paid, as his tax of one-fifth the proceeds of his mine, $11,000,000. The mine of Arevalo, in 1811, yielded in seven weeks, $200,000 from one level called El Divino Pastor. The Biscaina vein, which in 1726 had produced $4,341,600, and was subsequently abandoned on account of water, was re-opened in 1762, and in twelve succeeding years produced $6,000,000. The mines discovered by the Indian brothers Arauco, in the district of Morelos, in 1826, produced in two months $270,000. In 1825, the owner of the mine of Nuestra Senora de Guadaloupe refused $1,000,000 for the privilege of working it *three* years.

The mine of Arevalo at Chico, is stated to have produced from 1804 to

1824, $250,000 per annum. The mines at Real De Arriba in the district of Temascaltepec produced weekly twelve bars, or $18,000. The Santa Rita mines at Zimapan, upon the years 1791, 1792 and 1798 left a profit of $100,000.

Humboldt estimated the whole produce of the Mexican mines in 1803, at $1,767,952,000.

The enormous profits of the mines mentioned above, are well authenticated facts taken from government records of taxation. They were accomplished with the rudest implements, and without skill, enterprise or capital. The average yield of the ores, according to Ward, did not exceed 2½ ounces to the cwt. of ore. The miners drained their works by carrying water in rawhide sacks up ladders of notched logs. The ores were raised in the same tedious and laborious manner; and the crushing and smelting performed with the exercise of as little skill and enterprise. And yet these mines have yielded the most enormous fortunes that have ever been acquired in the history of the world.

The northern mines are conceded by Ward, Humboldt and others, to be richer in the quality of their ores, and to be nearer the surface. Indeed the veins now owned by this Company all outcrop on the surface, and can be distinctly traced along the soil.

The Heintzelman mine from its first opening, yielded richer ores than the famous Real Del Monte at the depth of several hundred feet. These mines will therefore pay from the start. The officers of the company therefore believe that they make a low estimate when they assume that each mine will yield a net revenue of $10,000 per annum. It is less than one-tenth the yield of the poorest of the Mexican mines, and is therefore much less than what may reasonably be expected. The estimated annual produce may then be stated thus:

Santa Rita, 24 mines	$240,000
Arivaca, 25 mines	250,000
Cerro Colorado, 29 mines	290,000
San Coyetano, 2 mines,	20,000
Total estimated annual produce	$800,000

And this estimate is irrespective of any new veins that may be discovered and opened and of the agricultural value of the ranche, which, in that section, must be very great. That these views are borne out by the agent of the Company and the scientific gentlemen on the expedition, will be readily perceived from the following extracts from his letter of January 1, in which, after announcing the purchase of the Arivaca Ranche, he states: "This is a great acquisition, of value beyond computation or present imagination, because its resources are entirely undeveloped and unknown. The boundaries include four leagues, and inside of these boundaries are known to exist twenty-five or thirty silver mines which were worked by the Spaniards, and we may reasonably conclude many more different and distinct mines may be found on the same place unopened and undiscovered. This tract contains more mines than any other body of land in the territory, of the same size, and perhaps in the world; and is well known to Maj. Emory, Lt. Michler, Col. Gray, and all the military and scientific men who have visited this country. I would not give it for a German dukedom, because it is intrinsically and really worth more, and will become more and more valuable as developments and discoveries are made, for years."

Such is the opinion of men on the spot, who have had the opportunity of visiting in person many of the rich mines, not only in Mexico but in California. The actual experience of the miners at work on the Heintzelman Mine shows, that a force of *twelve* men can throw up three thousand dollars worth of silver ore per month from that one shaft. The engineers are engaged in erecting smelting works on the Arivaca Ranche, convenient to wood and water. The work is progressing vigorously, and will be continued till every one of the mines is put in a state of actual development.

For collateral evidence of the worth of these mines the reader is referred to *Ward's Mexico, in* 1827, and to *Wilson's Mexico, its Peasants and its Priests.*

DISCOVERIES IN THE GALENA LEAD MINES.

During the past winter there have been several very valuable "leads" struck in these mines. At Shurborough, on Capt. Esty's ground, there has been a fine "discovery," and the Hempstead diggings yield well. But the largest lead (or more properly lode) which has ever been discovered in the mines, is about ten miles from this city, near Hazel Green. It is considered good for *six millions* of pounds of mineral. The fortunate discoverer, who is an Englishman by the name of Mills, can take one hundred thousand dollars for his "show" as it stands. With the exception of some twenty-two hundred pigs shipped at Dubuque, Galena will send off this year nearly the entire product of the Galena mines.

EXTRACTION OF SILVER FROM LEAD.

A thoroughly scientific process of separating silver from lead has been originated by a Mr. Patterson, an English inventor. It is founded on the property which fused lead has of becoming solid, or crystallizing, at a lower temperature than silver, so that if a quantity of argentiferous Galena be reduced to the liquid state, and then allowed to cool, solid crystals of nearly pure lead will be formed; these can be separated by means of an iron strainer, and in proportion as this is done, the liquid mass left behind becomes richer and richer in silver. The operation is conducted in hemispherical cast iron pans, each holding about three tons of metal, and heated by a fire below. The process is repeated three or four times for each charge, and the rich silver is finally purified from the lead by cupellation.

MISCELLANIES.

THE USE OF THE BLOWPIPE BY WORKING MINERS.

The miner will commonly judge a mineral to be metallic, if it has a metallic aspect, not destroyed by scraping, or if it feels particularly heavy in the hand; but others also discover metallic qualities to the blowpipe by—

1. Yielding a bead of metal to the reducing flame, on charcoal, which is facilitated by the addition of soda.
2. Passing off in vapor more or less dense.
3. Attracting the magnetic needle, after heating in the reducing flame on charcoal.
4. Coloring borax strongly, either on charcoal or pipe clay.

When a metallic bead is produced, it may be pure silver, tin, lead, bismuth, copper, gold, or iron; copper, nickel, or cobalt, alloyed with arsenic, or a mixture of various metals. Gold and silver may be distinguished by not losing their brilliancy in the outer flame; tin by its whiteness and softness; lead and copper are immediately distinguished by their color; and bismuth by fuming and evaporating in the reducing flame. The arsenical alloys and compounds, not clearly distinguished by these means, nor by their streak upon the black flint, must be examined by fluxing with borax. If it give green on pipe clay, it is copper, though it happened to be bleached by the arsenic. If blue, it is cobalt. If orange yellow while hot, and the color fly on cooling, it is

iron or nickel; and these are distinguished by their reducing flame on charcoal, where the borax bead is bottle-green with iron, but almost colorless with nickel. If the metal yield no bead, but pass off in vapor, it is quicksilver, arsenic, antimony, bismuth, or possibly tellurium, cadmium, or zinc. If the vapor smell strongly of garlic, it is arsenic. If it leave a circular halo on the charcoal, it is antimony, tellurium, bismuth, or cadmium. If the halo be white, it is antimony. If orange-yellow, it is to be subjected to the reducing flame. If it disappear easily, tinging the flame green, it is tellurium. If it evaporate with difficulty, and without tinging the flame, it is bismuth. If it be red or orange-red, it is cadmium. If the mineral evaporate readily with no odor, or only that of sulphur, and without leaving a white or yellow halo, it probably contains quicksilver, which is proved, if on mixing a portion of it with soda and iron filings, heating it on charcoal, and holding a bit of gold coin in the vapor, the quicksilver show itself on the coin. If, using soda, with the reducing flame, the assay burn after a while with a pale green flame and white smoke, covering the charcoal with a white flaky powder, it contains zinc. If it will neither yield a bead of metal, nor volatilize, but attract the magnetic needle after the operation of the reducing flame, it most probably contains iron, but it may be nickel or cobalt—easily distinguished by fluxing with borax. If the mineral, or the residue after part has evaporated, will neither yield a bead, volatilize, nor attract the magnetic needle, we have then to flux it with borax, and the following table will show what it contains:—

If it stain the borax,			
In the reducing flame, on charcoal.	In the calcinating flame, on pipe clay.	The metal is	Estimation.
Blue	Blue	Cobalt	Valuable for coloring glass, etc.
Bright green	Colorless	Chrome	Valuable for coloring glass, and for paints.
Colorless or reddish	Bluish green	Copper	Valuable.
Bottle green	Orange while hot, bleaches in cooling.	Iron	Of no value unless near coal.
Pale	As iron	Nickel	Valuable.
Dirty green	Yellow	Urani m	Not used.
Purple	C lorless	Titanium	Ditto.
Colorless	Purple	Manganese	Valuable for bleaching.

Copper is reduced to the metallic state in the reducing flame, and hence when in quantity shows itself in its usual red color in the bead.

In mixtures of metals the indications are sometimes ready enough. If on pipe-clay we find the borax tinged between orange and purple while hot, and becoming purple in cooling, while it gives a bottle green on charcoal, we immediately perceive the indications of iron and manganese—a very common mixture. If, again, we find it bright green on pipe clay, and emerald green on charcoal, a mixture of chrome and copper is indicated. But it more frequently happens, that mixtures of metals give ambiguous results, and that they can only be ascertained by caution and perseverance.

Although most of this is sufficiently easy, it requires a little practice, and to give the operator confidence in his results, this is best performed upon substances which he knows to contain the metals he assays for. Thus, if he operates on common mundic, he is certain, after a sufficient time of roasting and heating on charcoal, to obtain a residuum capable of affecting the magnetic needle. White mundic will leave the same residue, after giving off an arsenical smoke. Green copper (malachite), will be sure to yield a bead of copper on charcoal, and will as certainly produce a fine green with borax on

pipe clay. Any of the ores of lead may be promptly reduced to a metallic bead on charcoal.

The vapor of antimony may be promptly distinguished from that of arsenic, by the garlic odor of the latter. A minute particle of manganese will tinge borax a fine purple on pipe clay, in the outer flame; but on charcoal in the blue flame, a much larger portion dissolved in borax, will become limpid and colorless. A particle of titanium ore will give an opposite result, bleaching on the pipe clay, and becoming purple on the charcoal.

The experimenter should also not fail to reduce tin ore by the aid of soda, and some ore of zinc by the same means, that he may become acquainted with the appearances in these assays. Thus varying his practice as materials happen to fall in his way, he will quickly acquire familiarity with the appearances and results, and feel confidence in any assay he may undertake.

COMPOSITION OF STEEL. BY CHRISTOPHER BINKS.

What the Examination of some known Processes of Converting Iron into Steel would Indicate.—The researcher for information among the steel-makers and steel-workers, will speedily find abundance of instructive and suggestive facts, the careful study of any one of which may possibly give him the clue he seeks for. Let him, for example, in the first instance, carefully examine the phenomena involved in the very old practice of using ferrocyanide of potassium as an agent of conversion. It is well known that the application of this compound to heated iron, instantaneously converts that portion of the metal that is brought in actual contact with it into steel; and that, under a continued contact, the entire mass, as well as merely the surface of any piece of iron, equally undergoes this transmutation. Thus, this agent is used to improve the quality of inferior steel—that is, more completely to effect the conversion of iron into steel; it is also sometimes resorted to to renew or to restore the steel quality of steel tools—for example, of chisels, the repeated heatings and forgings of which have decomposed the steel externally, or to a greater or less depth reconverted it into common iron. It is used more especially to case-harden iron—that is, to give it an external coating of steel, or to improve soft steel by its more complete or perfect conversion superficially. This ferrocyanide of potassium is a *carbon* compound, containing, in its anhydrous form, no oxygen, and, doubtless, it would be on some theory of its carbon-giving agency, that its application (could we possibly trace the origin of it) to iron was first made. But, besides carbon, it contains also iron, nitrogen and potassium. Its formula is, K 2 Fe Cy 3 (or 3 NC 2).

Now, the specific action of this re-agent, or the cause of its producing this singular effect—the instantaneous conversion, at the points of contact, of iron into steel—might, *a priori*, be held to be due to one or other of the following kinds of reactions:

1. To the reduction of some portion of the carbon of the re-agent, and its being taken up by the hot metal, with the usual result of such a combination as viewed on the old theory of what steel is.

2. To a deposition upon the surface of the hot metal of a thin film of the pure iron, combined in some peculiar proportion or manner with the pure carbon, both of which exist in this re-agent itself.

3. To some peculiar action of the potassium present in the re-agent; or,

4. To some peculiar action of the nitrogen of the re-agent, or of that element and its associated carbon existing there in the form of cyanogen.

For merely preliminary trials or indications, let there be selected some ready method of determining which of these elements, or combination of them, plays this part of conversion; and, for this purpose, let these be taken as the test—the formation or the nonformation upon the surface of soft iron of a case-hardened surface, or of a superficial coating of steel as the result of an application to the iron of one or other of the following re-agents—the relative hardness of the surface being determined by the file test, and after tempering

by dipping the hot metal in water in the usual manner, and this, together with the color test, that is, the development of the series of colors under different degrees of heat peculiar to steel, being taken as the test of its formation.

Let the kind of iron that is selected be the best and commercially the purest malleable iron, such as would be chosen for conversion into the best steel.

The manner in which the writer proceeded in these trials was as follows: Little bars of this iron were made red hot in a porcelain tube, and then the re-agent was washed over or sprinkled upon its clean surface, or the gaseous or volatile matter (when such was used) was passed through the tube holding the red-hot bars. When the charcoal experiment was made, freshly made and pulverized boxwood charcoal was selected: this was made red-hot to expel adhering azotised or other gaseous matter; then quickly transferred to the tube, the rod of iron imbedded in it, and the two ends of the tube closed. When to the last arrangement atmospheric air was added, the ends of the tube, placed horizontally, were left open, and the air, by diffusion, or by a quiet interfusion, found its way into and within the body of the charcoal, and, of course, into contact with the heated iron.

It is needless to point out that this line of experimenting is calculated to obtain, and aims at obtaining only very broad indications of reactions and effects, for the iron used is only approximately and not absolutely pure. But the indications of the special action of each re-agent on its application to the iron are so marked and distinctive, and develop themselves so broadly under the above system of testing, that this method of detecting the reactions, though not absolutely unqualified in its accuracy, is sufficiently tangible for its intended purpose, and lies within the reach of every one. It will be seen how, in following up this investigation, for those comparatively rude methods there are substituted others aiming at great precision, which will appear in a subsequent chapter. The temperature under which the following several re-agents were applied to the iron was that of a full red heat, or that usually employed in case-hardening, or in the cementation process of conversion. Let any experimentalist proceed in this manner to apply to heated iron the following special re-agents, and he will find:

1. The heated iron exposed to the action of pure carbon, and kept out of reach of contact with any other element, is not converted into steel. A small rod of the malleable iron packed in boxwood charcoal in the closed porcelain tube, and kept at full red heat for 12 hours, did not, after being tampered, show a hard steel surface, nor did it exhibit, under high and different degrees of heat, the play of colors peculiar to real steel. It still remained malleable iron.

2. But that when atmospheric air is admitted to such an arrangement in such quantity only as still to keep the carbon in excess, then, in the first instance, the surface of the iron, and finally (if the time of contact be long enough) the whole of the iron is converted into steel.

3. That the application to the iron of gaseous nitrogen does not produce steel.

4. That neither does the application of carbonic oxide give steel.

5. That the application to the iron of a hydro-carbon (as when olefiant gas is passed through the tube, or when the red-hot rod is dipped in oil containing no nitrogen) does not produce steel.

6. But that the application of olefiant gas mixed with ammonia, or the application of gaseous cyanogen, produces steel, as does also the dipping of the hot metal into a nitrogenized oil, or fat.

7. That the application of ferrocyanide of potassium (as has been so long known) gives steel.

8. That, equally with the ferrocyanide, does the application of the simple cyanide of potassium result in the production of steel; therefore, it is not to

the iron contained in ferrocyanide that the steel-making property of the latter salt is due.

9. That potash applied to the hot iron in contact with the vapor of potassium does not yield steel.

10. That with iron of the kind that has so far been referred to and used (*i. e.* commercially pure wrought iron, containing no material proportion of carbon), the application to it of ammonia, or of nitrate of ammonia, fails to produce steel.

11. But that the application of ammonia, or its muriate, to iron containing a considerable proportion of carbon, results in its conversion into steel.

These results tabulated, and the composition of the re-agents expressed in formulæ, will better exhibit the inevitable deductions to which they lead.

(1.)	Fe × C (in excess), every other element excluded),	Leaves iron.
(2.)	Fe × C (in excess) × (atmospheric air), . . .	Gives steel.
(3.)	Fe × N (gaseous nitrogen), ...	Leaves iron.
(4.)	Fe × C O (gaseous carbonic oxide), ...	Leaves steel.
(5.)	Fe × H4 C4 (olefiant gas, ...	Leaves iron.
(6.)	Fe × H4 C4 (in excess × NH_3 (ammonia), . . .	Gives steel.
(7.)	Fe × N C^2 (cyanogen), ...	Gives steel.
(8.)	Fe × K2, Fe Cy_3 (ferrocyanide of potassium), .	Gives steel.
(9.)	Fe × K, Cy (cyanide of potassium), . . .	Gives steel.
(10.)	Fe × KO (potash), ...	Leaves iron.
(11.)	Fe × K (potassium), ...	Leaves iron.
(12.)	Fe NH^3 (ammonia), ...	Leaves iron.
(13.)	Fe NH^3 Cl (sal ammoniac), ...	Leaves iron.
(14.)	$\frac{\quad}{95\quad 5}$ × NH^3 (ammonia), ...	Gives steel.
(15.)	$\frac{Fe \times C}{95\quad 5}$ × NH^3 (sal ammoniac), ...	Gives steel.

Now, out of a consideration of these preliminary and merely guiding trials, besides the other deductions they lead to, as those have been already stated, there is made apparent one significant fact, namely, the invariable co-operation, so far as these trials extend, of both nitrogen and carbon in the production of steel; but these co-operating in some manner yet to be defined and ascertained. It still remains to be determined if this co-operation of nitrogen be a *necessity* in steel-making, or if the apparent invariableness of its presence and co-operation will, on further examination, be borne out by the evidence of every other process; and if so, is it that the nitrogen, conjointly with the carbon, forms some combination with the iron and remains there; or, that the nitrogen acts merely as an intermediate agent, and that it still remains a chemical fact that steel is merely iron combined with carbon only, though nitrogen plays an essential part in effecting that combination.

Other Evidences of presumptive Co-operation.—But, whatsoever may be the functions in steel-making that are exercised by nitrogen—if its office be functional at all, and its presence be not a mere coincidence in every case—the fact of its invariable co-existence with carbon, whenever steel is produced, is incontrovertible.

We have it in the old ordinary cementation boxes, which, being filled with charcoal and the imbedded iron, are closed, but not hermetically sealed, and still sufficiently open to the inevitable permeation, through the excess of carbon, of atmospheric air, yielding, by its oxygen, carbonic oxide, and to the steel, nitrogen. We have it still more especially and obviously when, in this cementation process, there is superadded to the charcoal some horn, or leather shavings, or animal charcoal, along, sometimes, with an alkali—a very old, but not generally used modification. We have it when the iron for conversion is exposed in close vessels to the action of coal gas, but in which coal or gas, to greater or less-extent, there is always present either cyanogen, ammonia, or both. We have it also in the multifarious expedients of the steel-workers and steel tool-makers, resorted to to give increased hardness to the metal—that is, to effect its more complete conversion into steel; as, when the filemaker coats his file, before tempering it, with a composition of cow-

dung or with pig-flour—two favorite species, and both highly azotised substances, which he thinks useful not merely for protecting the sharp angles of his cuttings from the action of the fire, but which also act, in reality, in more completely steelifying his finished work. We have it in the use, in so many cases, of horn shavings, of horn dust, of leather shavings, and of other animal, and consequently azotised matters of various kinds; in the use of other vegetable substances (besides that just mentioned) containing large proportions of gluten, and consequently of nitrogen; in the use of the ammoniacal salts, to say nothing of the prussiates, the recognition of the potency, and of the great value of which for steel-making in bulk, as well as for merely hardening it superficially, as heretofore, is now becoming general.

We have a conspicuous instance of the effect of the presence of this element in a well-known fact, that whilst the dipping of the hot metal into olive oil fails, the use of beef suet (an azotised fat) succeeds in giving to the iron a coating of steel. It was the presence (but to him the unconscious one) of this same element, that gave to the celebrated expedient of Mr. Heath its chief potency in improving the quality of inferior steel, and not solely to any purifying or alloying action (if any) of his manganese; for latterly Mr. Heath used *coal-tar*, placed in contact with the steel, to reduce this manganese oxide; and this coal-tar is a highly nitrogenized as well as carbonized compound. In short, in whatever practice the various and continual trials of the steel artisan may result, in his searchings after the best hardening agents (and he resorts to the most extraordinary things), that practice will be found invariably, when successful, to involve the employment of some material in which nitrogen is an essential element.

UTILIZATION OF PEAT.

At a meeting of the Dublin Chemical Society, Mr. J. J. Hays read his valuable paper "On a New Mode of Compressing Peat, and its Applicability to Industrial purposes." The subject being one of great interest, the attendance was, of course, numerous. Mr. Hays commenced by saying—"That his sole object had been to procure at a cheap rate from peat the four principal products—Charcoal, gas, and ammoniacal liquor, and that having for the last nine years given his undivided attention to the subject—living amongst the bogs, and making the economy of labor his especial study, he trusted he had at last solved the embarrassing problem of making from common turf an excellent fuel, little if at all inferior to coal, and available in almost every district in Ireland."

Mr. Hays divided his paper into two parts,—the first had reference to charred peat, and the other to compressed peat. I will, therefore, allude to the subject in the order which he has himself done, by treating of the first, leaving till next week the consideration of the second part.

Mr. Hays had his attention drawn to the subject of peat in the year 1846, by a gentleman who had a plan by which he could pay all the expenses of carbonizing, by the sale of the products which he obtained during the process. Mr. Hays considering the subject one of great importance, determined on instituting experiments, and accordingly erected a model apparatus in London, and having tested to his satisfaction the correctness of the theory, he then erected at Dartmouth in Devon, works large enough to carry out his ideas on an extensive scale, and after a lapse of sixteen months, he succeeded in obtaining at a cheap rate and of a superior quality, a charcoal sufficiently dense to bear a blast, and, therefore, to be useful as a fuel for metallurgical and other purposes, and for it he obtained readily £8 per ton in London. Mr. Hays stated, that by his plan both tar and gas are saved by a very inexpensive process; the latter being used as a fuel to keep up the heat in the furnaces. The estimated cost of the manufacture, is 11s. 8d. per ton, thus: Cost of cutting and drying the peat, 1s. 6d.; carting to works, 6d.; stacking and other

expenses, 6d.; cost per ton of peat, 2s. 6d. As it takes three tons of peat to make one ton of charcoal, the cost of three tons would be, at 2s. 6d., 7s. 6d.; cost of charring, 2s. 6d.; landlord's royalty, 3d.; management, &c. 6d.; wear and tear 6d, equal to 11s. 3d. per ton.

The most economical plan of working is with nine pairs of retorts, which will turn out 108 ton of charcoal per week, each retort being charged six times in the 24 hours, with 10 cwt. in each charge, equal to three tons of peat or one of charcoal per day. The retorts are wrought iron one-eighth of an inch thick, set in brick or stone, with an arched space of four inches over each, and one furnace, heating two retorts. The heat being carried through flues, heats the arch, and is radiated to the peat within, causing it to be charred in a very uniform manner; and by shutting off the gas, and applying a light to a small burner in the pipe, the operator is enabled to find the pressure in the retort, which he can so regulate as to cause the charcoal to burn with or without flame, as may be required. The retorts are loaded with baskets made of hoop iron; in these the peat is packed, and when charred, is thus drawn out unbroken. The cost of each pair of retorts, including the setting, Mr. Hays estimates at £125; and he states that, by using peat as the fuel, the retorts become quite case-hardened, and last a long time. The quantity of tar he estimates at six per cent., though he obtained as much as 15 per cent. in some cases. He considers that one ton of peat would yield 184lbs., and 300 tons 40,200 lbs.; and this yield, at 10lbs. to the gallon, 4,020 gallons, which, if sold, at 3d. per gallon, would produce £50 5s.; and this sum when deducted from the cost of obtaining 108 tons of charcoal at 11s. 3d., say £61 5s., leaves only £11, as the cost of the 108 tons of charcoal. A ton of peat yields also from 30 to 50 gallons of ammoniacal liquor. The suitability of the charcoal for the purposes for which it is hoped it will be principally applied in Ireland—namely the reduction of the iron ores. Mr. Hays stated he proved at the Iron and Tin Plate works of Mr. James Brown, of Abertillery, Monmouth, where he states it gave much satisfaction, affording great heat, without the presence of either sulphur or smoke.

MINES IN AUSTRIA.

A work has been published at Vienna, under the title of "Geological *Coup-d'œil* of Mines in the Kingdom of Austria," which contains some useful information. Gold is found in Bohemia, Moravia and Silesia; at Bergreichenstein, on the river Watawa; at Eule, to the south of Prague; at Tok; and at Mileschow, to the south-east of Pribram. The metal is found in beds and veins of auriferous quartz; sometimes enclosed in gneiss, as in the Mountains of Bohmer Wald, and in other instances in granite, as in the Alpine regions; at Zell. in Tyrol; Schwaig and Leugholz, Radlgraben and Raderzeche, in Carinthia; in the regions of the Carpathians; at Bosing, to the north of Presburg; at Buesum and Vorospatak, in Transylvania (the green sands of which are impregnated with native gold); and at Mount-Vulkoj, Zaluthna. Silver exists at Tabor and at Ober-Lischnitz, in Bohemia, and elsewhere, combined with other metals, particularly lead, as at Kattenberg, Ratiboritz, and Jung-Wozitz, Admstadt, Kruman, Klosterrab, Niklasberg, Johannisberg, and Benisch. The veins are found enclosed in gneiss. Lead at Mies, and in the neighborhood, is extensively worked. The minerals obtained from lodes of crystalline, clayey schistus, close to the town of Mies; at Neu-Metternich, Promenhof, and Blerstadt; at Altdorf, in Moravia; in the Alpine districts; at Plescherken, in Carinthia; at Laas, St Martin, and Saversnig, in Carniola; at Paak and Dranwald, in Styria; at Schwarzenberg, in Austria Proper; at Arsiera and Argentiera, in the Venetian provinces; at Janken, Windesch-Blerberg, Obir, and Petzen, in Carinthia; in the Carpathian, and at Muntzel, in Transylvania. Copper at Tschauer-Schmelzthal Grasseletz, in Bohemia, is found in large compact masses of iron and copper pyrites, deposited longitudinally in quartzose gneiss, at Hohenthal, in Si-

lesia; the lode is enclosed in crystalline schistus at Chrast, in Bohemia; in the Alpine ranges; at Muhr, in Lungau; at Kardeis, in the valley of Grassarl; Breunthal and Ahrn, in Tyrol; Gross-Fragant, Kallwang, Radmer, and Johnsbach, in Styria; Metterberg, Zellam-See, Ketzbühel, in Tyrol; Agordo, in the Venetian provinces; Arza, in Carinthia; in the Carpathian regions; at Dialu Negru, in Brikowina; and at Balan, in Transylvania. Tin exists at Zinwald, in Bohemia, where the mineral is enclosed in ellipsoidal masses of granite, which are again enveloped by porphyry; at Graussen and Schlaggenwald, tin is not found in a metallic state. Arsenic is found at Hawlowitz, Pressnitz; in the Alpine regions; and at Rothgulden, in Lungan, but nowhere else. Zinc is extracted from mines at Sgota, to the north-west of Cracow; in the neighborhood of the Alps; also at Schonstein, in Styria; elsewhere it is found allied with other metals, particularly lead. Antimony is found at Radlberg. Nickel and cobalt exist at Shladming, in Styria; Nockelberg and Leogand in the district of Salzburg; in the Carpathian ranges; and at Dobschan, in Hungary. Chromium is found at Kraubat, in Styria. And mercury at Zolz, in Styria; Kappel, Buchholzgeshen, and Reichnau, in Carinthia; in the Carpathian regions; and at Pogana Stampi, in Bukowina. All these metals are found amalgamated one with another, and give rise to considerable workings. In the native state, or mixed with other metals, they are found in crystalline rocks, greywacke, red sandstone, shelly limestone, the schistus of Werfen, the Alpine limestone, the Carpathic sandstone, and in volcanic rocks.

WHAT RANK MUST BE ASSIGNED TO ALUMINIUM?

This metal ranks not far from silver in its action upon water and oxygen; near the alkaline metals in its action upon silicic, boracic, and carbonic acids, and near iron in its action upon the metallic oxides; in fact, it decomposes all the oxides which are decomposed by iron, except the oxide of zinc. According to the last peculiarity, aluminium would have less affinity for oxygen than iron, and would range beside iron, but below it. In considering what place aluminium should occupy in the electro-chemical series, we find that it precipitates all the metals from their chlorides up to lead and cadmium inclusive, so that it comes between cadmium and iron. To sum up, until chemistry has made further progress, we must not hope to assign aluminium an exact place in the classifications. However, as M. Sainte-Claire Deville has said, it will certainly be least out of place by the side of iron. We know, in fact, that at a high temperature, iron also decomposes silicic, boracic and carbonic acids; and if aluminium has not the same action upon oxygen and water as iron, it is, as M. Deville has also observed, because we do not know of an oxide of aluminium of the formula R_3O_4, an oxide which iron always tends to produce at a high temperature. Lastly, taking into consideration the electro-chemical properties, it is still in the neighborhood of iron that aluminium would be placed.

The remarkable properties which distinguish this metal from all others are, therefore,—1. its slight density.—2. Its resistance to the actions of the oxyacids and sulphuretted compounds, which approximates it to gold and platinum.—3. The difficulty with which it enters into alloys, a property which is not shared by the other malleable metals; for iron, zinc, lead, tin, copper, silver, gold, and platinum are capable of forming more or less malleable alloys, whilst aluminium cannot bear more than 10 per cent. of foreign metal, or enter into combination itself in greater proportion, without greatly modifying the ductility of the metal with which it is alloyed.—C. Tissier: *Comptes Rendus.—Chemical Gazette.*

ON THE ANOMALIES PRESENTED BY ALUMINIUM.

Relation between the Density and Alterability.—Hitherto the least oxidizable metals have been amongst the heaviest, such as mercury, silver, gold and platinum; nevertheless, aluminium, the density of which is only 2.56, is the least alterable of all the ordinary metals, after silver, gold, and platinum.

MINING MAGAZINE.

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Mines, Mining Operations, Metallurgy, &c., &c.

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ART. I.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 8.

(Continued from page 216, vol. ix)

A Table showing the Number of Ounces and Parts of an Ounce of Silver contained in a Ton of Ore, by Assaying produced from one ounce Averdupois.

Assay.	Per Ton.			Assay.	Per Ton.			Assay.	Per Ton.		
grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.
1·32	2	6	16	6	448	0	0	⅛	905	6	16
1·16	4	13	8	⅛	457	6	16	¼	914	13	8
⅛	9	6	16	¼	466	13	8	⅜	924	0	0
¼	18	13	8	⅜	476	0	0	½	933	6	16
⅜	28	0	0	½	485	6	16	⅝	942	13	8
½	37	6	16	⅝	494	13	8	¾	952	0	0
⅝	46	13	8	¾	504	0	0	⅞	961	6	16
¾	56	0	0	⅞	513	6	16	13	970	13	8
⅞	65	6	16	7	522	13	8	⅛	980	0	0
1	74	13	8	⅛	532	0	0	¼	989	6	16
⅛	84	0	0	¼	541	6	16	⅜	998	13	8
¼	93	6	16	⅜	550	13	8	½	1008	0	0
⅜	102	13	8	½	560	0	0	⅝	1017	6	16
½	112	0	0	⅝	569	6	16	¾	1026	13	8
⅝	121	6	16	¾	578	13	8	⅞	1036	0	0
¾	130	13	8	⅞	588	0	0	14	1045	6	16
⅞	140	0	0	8	597	6	16	⅛	1054	13	8
2	149	6	16	⅛	606	13	8	¼	1064	0	0
⅛	158	13	8	¼	616	0	0	⅜	1073	6	16
¼	168	0	0	⅜	625	6	16	½	1082	13	8
⅜	177	6	16	½	634	13	8	⅝	1092	0	0
½	186	13	8	⅝	644	0	0	¾	1101	6	16
⅝	196	0	0	¾	653	6	16	⅞	1110	13	8
¾	205	6	16	⅞	662	13	8	15	1120	0	0
⅞	214	13	8	9	672	0	0	⅛	1129	6	16
3	224	0	0	⅛	681	6	16	¼	1138	13	8
⅛	233	6	16	¼	690	13	8	⅜	1148	0	0
¼	242	13	8	⅜	700	0	0	½	1157	6	16
⅜	252	0	0	½	709	6	16	⅝	1166	13	8
½	261	6	16	⅝	718	18	8	¾	1176	0	0
⅝	270	13	8	¾	728	0	0	⅞	1185	6	16
¾	280	0	0	⅞	737	6	16	16	1194	13	8
⅞	289	6	16	10	746	13	8	⅛	1204	0	0
4	298	13	8	⅛	756	0	0	¼	1213	6	16
⅛	308	0	0	¼	765	6	16	⅜	1222	13	8
¼	317	6	16	⅜	774	13	8	½	1232	0	0
⅜	326	13	8	½	784	0	0	⅝	1241	6	16
½	336	0	0	⅝	793	6	16	¾	1250	13	8
⅝	345	6	16	¾	802	13	8	⅞	1260	0	0
¾	354	13	8	⅞	812	0	0	17	1269	6	16
⅞	364	0	0	11	821	6	16	⅛	1278	13	8
5	373	6	16	⅛	830	13	8	¼	1288	0	0
⅛	382	13	8	¼	840	0	0	⅜	1297	6	16
¼	392	0	0	⅜	849	6	16	½	1306	13	8
⅜	401	6	16	½	858	13	8	⅝	1316	0	0
½	410	13	8	⅝	868	0	0	¾	1325	6	16
⅝	420	0	0	¾	877	6	16	⅞	1334	13	8
¾	429	6	16	⅞	886	13	8	18	1344	0	0
⅞	438	13	8	12	896	0	0	⅛	1363	6	16

Assay	Per Ton.			Assay	Per Ton.			Assay.	Per Ton.		
grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.
18¼	1362	13	8	28	2090	13	8	37¾	2818	13	8
⅜	1372	0	0	⅛	2100	0	0	⅞	2828	0	0
½	1381	6	16	¼	2109	6	16	38	2837	6	16
⅝	1390	13	8	⅜	2118	13	8	⅛	2846	13	8
¾	1400	0	0	½	2128	0	0	¼	2856	0	0
⅞	1409	6	16	⅝	2137	6	16	⅜	2865	6	16
19	1418	13	8	¾	2146	13	8	½	2874	13	8
⅛	1428	0	0	⅞	2156	0	0	⅝	2884	0	0
¼	1437	6	16	29	2165	6	16	¾	2893	6	16
⅜	1446	13	8	⅛	2174	13	8	⅞	2902	13	8
½	1456	0	0	¼	2184	0	0	39	2912	0	0
⅝	1465	6	16	⅜	2193	6	16	⅛	2921	6	16
¾	1474	13	8	½	2202	13	8	¼	2930	13	8
⅞	1484	0	0	⅝	2212	0	0	⅜	2940	0	0
20	1493	6	16	¾	2221	6	16	½	2949	6	16
⅛	1502	13	8	⅞	2230	13	8	⅝	2958	13	8
¼	1512	0	0	30	2240	0	0	¾	2968	0	0
⅜	1521	6	16	⅛	2249	6	16	⅞	2977	6	16
½	1530	13	8	¼	2258	13	8	40	2986	13	8
⅝	1540	0	0	⅜	2268	0	0	⅛	2996	0	0
¾	1549	6	16	½	2277	6	16	¼	3005	6	16
⅞	1558	13	8	⅝	2286	13	8	⅜	3014	13	8
21	1568	0	0	¾	2296	0	0	½	3024	0	0
⅛	1577	6	16	⅞	2305	6	16	⅝	3033	6	16
¼	1586	13	8	31	2314	13	8	¾	3042	13	8
⅜	1596	0	0	⅛	2324	0	0	⅞	3052	0	0
½	1605	6	16	¼	2333	6	16	41	3061	6	16
⅝	1614	13	8	⅜	2342	13	8	⅛	3070	13	8
¾	1624	0	0	½	2352	0	0	¼	3080	0	0
⅞	1633	6	16	⅝	2361	6	16	⅜	3089	6	16
22	1642	13	8	¾	2370	13	8	½	3098	13	8
⅛	1652	0	0	⅞	2380	0	0	⅝	3108	0	0
¼	1661	6	16	32	2389	6	16	¾	3117	6	16
⅜	1670	13	8	⅛	2398	13	8	⅞	3126	13	8
½	1680	0	0	¼	2408	0	0	42	3136	0	0
⅝	1689	6	16	⅜	2417	6	16	⅛	3145	6	16
¾	1698	13	8	½	2426	13	8	¼	3154	13	8
⅞	1708	0	0	⅝	2436	0	0	⅜	3164	0	0
23	1717	6	16	¾	2445	6	16	½	3173	6	16
⅛	1726	13	8	⅞	2454	13	8	⅝	3182	13	8
¼	1736	0	0	33	2464	0	0	¾	3192	0	0
⅜	1745	6	16	⅛	2473	6	16	⅞	3201	6	16
½	1754	13	8	¼	2482	13	8	43	3210	13	8
⅝	1764	0	0	⅜	2492	0	0	⅛	3220	0	0
¾	1773	6	16	½	2501	6	16	¼	3229	6	16
⅞	1782	13	8	⅝	2510	13	8	⅜	3238	13	8
24	1792	0	0	¾	2520	0	0	½	3248	0	0
⅛	1801	6	16	⅞	2529	6	16	⅝	3257	6	16
¼	1810	13	8	34	2538	13	8	¾	3266	13	8
⅜	1820	0	0	⅛	2548	0	0	⅞	3276	0	0
½	1829	6	16	¼	2557	6	16	44	3285	6	16
⅝	1838	13	8	⅜	2566	13	8	⅛	3294	13	8
¾	1848	0	0	½	2576	0	0	¼	3304	0	0
⅞	1857	6	16	⅝	2585	6	16	⅜	3313	6	16
25	1866	13	8	¾	2594	13	8	½	3322	13	8
⅛	1876	0	0	⅞	2604	0	0	⅝	3332	0	0
¼	1885	6	16	35	2613	6	16	¾	3341	6	16
⅜	1894	13	8	⅛	2622	13	8	⅞	3350	13	8
½	1904	0	0	¼	2632	0	0	45	3360	0	0
⅝	1913	6	16	⅜	2641	6	16	⅛	3369	6	16
¾	1922	13	8	½	2650	13	8	¼	3378	13	8
⅞	1932	0	0	⅝	2660	0	0	⅜	3388	0	0
26	1941	6	16	¾	2669	6	16	½	3397	6	16
⅛	1950	13	8	⅞	2678	13	8	⅝	3406	13	8
¼	1960	0	0	36	2688	0	0	¾	3416	0	0
⅜	1969	6	16	⅛	2697	6	16	⅞	3425	6	16
½	1978	13	8	¼	2706	13	8	46	3434	13	8
⅝	1988	0	0	⅜	2716	0	0	⅛	3444	0	0
¾	1997	6	16	½	2725	6	16	¼	3453	6	16
⅞	2006	13	8	⅝	2734	13	8	⅜	3462	13	8
27	2016	0	0	¾	2744	0	0	½	3472	0	0
⅛	2025	6	16	⅞	2753	6	16	⅝	3481	6	16
¼	2034	13	8	37	2762	13	8	¾	3490	13	8
⅜	2044	0	0	⅛	2772	0	0	⅞	3500	0	0
½	2053	6	16	¼	2781	6	16	47	3509	6	16
⅝	2062	13	8	⅜	2790	13	8	⅛	3518	13	8
¾	2072	0	0	½	2800	0	0	¼	3528	0	0
⅞	2081	6	16	⅝	2809	6	16	⅜	3537	6	16

Assay	Per Ton.			Assay	Per Ton.			Assay.	Per Ton.		
grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.	grs.	oz.	dwts.	grs.
47½	3546	13	8	51¾	3864	0	0	56	4181	6	16
⅝	3556	0	0	⅞	3873	6	16	⅛	4190	13	8
¾	3565	6	16	52	3882	13	8	¼	4200	0	0
⅞	3574	13	8	⅛	3892	0	0	⅜	4209	6	16
48	3584	0	0	¼	3901	6	16	½	4218	13	8
⅛	3593	6	16	⅜	3910	13	8	⅝	4228	0	0
¼	3602	13	8	½	3920	0	0	¾	4237	6	16
⅜	3612	0	0	⅝	3929	6	16	⅞	4246	13	8
½	3621	6	16	¾	3938	13	8	57	4256	0	0
⅝	3630	13	8	⅞	3948	0	0	⅛	4265	6	16
¾	3640	0	0	53	3957	6	16	¼	4274	13	8
⅞	3649	6	16	⅛	3966	13	8	⅜	4284	0	0
49	3658	13	8	¼	3976	0	0	½	4293	6	16
⅛	3668	0	0	⅜	3985	6	16	⅝	4302	13	8
¼	3677	6	16	½	3994	13	8	¾	4312	0	0
⅜	3686	13	8	⅝	4004	0	0	⅞	4321	6	16
½	3696	0	0	¾	4013	6	16	58	4330	13	8
⅝	3705	6	16	⅞	4022	13	8	⅛	4340	0	0
¾	3714	13	8	54	4032	0	0	¼	4349	6	16
⅞	3724	0	0	⅛	4041	6	16	⅜	4358	13	8
50	3733	6	16	¼	4050	13	8	½	4368	0	0
⅛	3742	13	8	⅜	4060	0	0	⅝	4377	6	16
¼	3752	0	0	½	4069	6	16	¾	4386	13	8
⅜	3761	6	16	⅝	4078	13	8	⅞	4397	0	0
½	3770	13	8	¾	4088	0	0	59	4406	6	16
⅝	3780	0	0	⅞	4097	6	16	⅛	4415	13	8
¾	3789	6	16	55	4106	13	8	¼	4424	0	0
⅞	3798	13	8	⅛	4116	0	0	⅜	4433	6	16
51	3808	0	0	¼	4125	6	16	½	4442	13	8
⅛	3817	6	16	⅜	4134	13	8	⅝	4452	0	0
¼	3826	13	8	½	4144	0	0	¾	4461	6	16
⅜	3836	0	0	⅝	4153	6	16	⅞	4470	13	8
½	3845	6	16	¾	4162	13	8	60	4480	0	0
⅝	3854	13	8	⅞	4172	0	0				

METHOD OF COMPUTING THE VALUE OF LEAD AND SILVER ORE.

EXAMPLE.

Required the value of 16 tons, 10 cwt. 2 qrs. of lead and silver ore, the produce for lead being 8 5-8 in 20, and silver 3 7-8 grs. from a four-ounce sample. The price of lead £22 per ton, and silver 5*s.* 3*d.* per oz. Returning charges £6 10*s.* per ton, and lord's dues one twelfth for lead, and one eighth for silver.

OPERATION.—LEAD.

	tons.	cwt.	qr.				
½	16	10	2				
			8				
	132	4	0				
⅛	8	5	1				
	2	1	1				
*20)	142	10	2				
				l. *s.*	*l.*	*s.*	*d.*
	7	2	2	at 15 10† per ton	110	2	6
	Deduct dues one twelfth				9	3	6
					100	19	0

* It is not usual to make any allowance for waste on rich ores.

† Returning charge deducted.

OPERATION.—SILVER.

By table, (page 299.) produce $3\frac{7}{8}$ is 72 oz. 6 dwt. 16 grs. per ton, ($3\frac{7}{8} \div 4 = \frac{31}{32}$) and

tons.	cwt.	qrs.		oz.	dwt.	grs.		oz.		s.	d.	l.	s.	d.
7	2	2	×	72	6	16	=	514	at	5	3	134	18	6
Deduct dues one eighth										16	17	4		
												118	1	2
Answer												219	0	2

METHOD OF COMPUTING THE VALUE OF COPPER ORE.

EXAMPLE.

What is the value of 74 tons, 13 cwt. 2 qrs. of copper ore, the produce, by assay, being 7 1–8, and standard £127 12*s.* 6*d.*?

OPERATION.

	l.	s.	d.
⅛	127	12	6
			7
	893	7	6
	15	19	0¾
	9·09	6	6¾
	20		
	1·86		
	12		
	10·38		

THEN

	l.	s.	d.	
From	9	1	10	
Deduct	2	10	0	per ton returning charge.
	6	11	10	

	ton.		l.	s.	d.		tons.	cwt.	qrs.
Again, If	1	:	6	11	10	: :	74	13	2

BY PRACTICE.

cwt.		l.	s.	d.
10½	½	6	11	10
				9
		59	6	6
				8
		474	12	0
		13	3	8
		487	15	8
		3	5	11
3	$\frac{1}{7}$	0	18	10
Answer		492	0	5

Copper ores are always computed at 21 cwt. to the ton, the surplus being allowed for waste in carriage, &c.

RULE FOR DISCOVERING THE POWER OF STEAM ENGINES.

1. Square the diameter of the cylinder, multiply the sum by ·7854* and the product by 10†: lastly, multiply again by 144‡,

* The established ratio of the diameter. Or look in the table, page 305, where the square inches contained in a cylinder are given, and take out the number standing opposite the given diameter.

† That is, considering the power equal to 15 lbs. to an inch, and allowing 5 lbs. or one third for friction.

‡ Considering the stroke to be 8 feet, and the engine to go 9 strokes per minute.

and the last product will show the number of pounds the engine lifts a foot high in a minute.

2. A horse is estimated to raise 500 lbs. 64 feet high, or 1000 lbs. 32 feet high, or 32,000 lbs. 1 foot high in a minute, consequently, if the last product be divided by 32,000, the quotient will show the number of horses required to equal the power of the engine.

EXAMPLE.

What is the power, and horse power of a steam engine, the cylinder being 46 inches in diameter?

```
         46+46=2116
              7854
         ----------
         1661·9064
                10
         ----------
        16619·0640
               144
        -----------
32000) 2393145·2160 (75
       224000
       ------
        153145
        160000
        ------
```

ANSWER.

Engine lifts 2,393,143 lbs. one foot high in a minute.
Equal to 75 horses, nearly.

RULE FOR DISCOVERING THE POWER OF A WATER ENGINE.

1.—Multiply the length, breadth, and depth of the bucket together, and divide by 282, (the number of cubic inches in a gallon, beer measure,) multiply the quotient by 10 1–5 lbs. or 10 lbs. 3·2 oz. or 10·2 lbs. the weight of a gallon of water.*

2.—Multiply the diameter of the wheel by 3·1416 (the ratio of the circle), and divide the product by the circular space occupied by each bucket—the quotient will show the number of buckets contained in the wheel.

3.—Multiply the third part† of the number of buckets by the weight of water contained in one, then

4.—For the leverage—From the radius, or half the diameter, deduct the length of the crank, and one third of the remainder will be the operative length of the lever; multiply the weight of water in one third of the wheel by this length (taking the feet for the whole number of the multiplier), and the product will show the full, or entire power. Lastly, from this product cast off 1–5 for friction‡, and the remainder will show the net or real power of the wheel.

* The result will be the same if the operation is done by the wine gallon, computing it to contain 231 cubic inches, and to weigh 8 lbs. 5·67 oz. or 8·355 lbs.

† There are differences of opinion respecting this; some persons contending that two fifths of the number of buckets are full at a time, but one third is the most general and the most reasonable proportion.

‡ Here again engineers are not unanimously agreed, some allowing one

EXAMPLE.

Required the power of a water-wheel, the diameter being 46 feet, the buckets 30 inches long, 12 inches deep, and 6 inches wide, with 1¼ inches between each bucket, and the crank 3 feet long.

OPERATION.

1.—To find the quantity and weight of water in each bucket.

30×12×6=2160÷282=7·66×10·2=78·13.

2.—To find the number of buckets contained in the wheel.

46×12=552×3·1416=1734 (6+1¼)÷7·25=239.

3.—To find the weight of water on ⅓ of the wheel.

239÷3=80×78·13=6250.

4.—To find the power of the lever.

46÷2=23—3=20÷3=6·66

and

6250×6·66=41625

Lastly, for friction.

```
5) 41625
    8325
```

Answer 33,300 lbs. the actual power of the wheel.

To find the depth at which a wheel will draw a column of water in a lift of pumps of any given dimensions.

Rule.—Find the power of a wheel by the foregoing method, then from the table,* take out the weight of water in a fathom of the given size pump. Divide the power of the wheel (in pounds) by this number, and the quotient will show the fathoms.

EXAMPLE.

The power of the fore-mentioned wheel is 33,300 lbs., how deep will she draw in a 12 inch lift of pumps?

294·53) 33300 (113

Answer 113 fathoms.

TO FIND THE HORSE-POWER OF A WHEEL.

Rule.—Multiply the power (found by the given rule, page 303) by the number of revolutions made by the wheel in a minute, and this product by the length of the stroke in feet, or double the length of the crank: divide the last product by 32,000, and the quotient will show the number of horses required to equal the power of the wheel.

fifth, some one fourth, and some even one third of the power, for friction. It is true the distance the wheel is placed from the work, and other contingent circumstances, must be taken into consideration; but in ordinary operations, where the wheel draws close, one fifth is very near the truth.

* See November Number.

EXAMPLE.

The fore-mentioned wheel is allowed to make seven revolutions in a minute; required the horse-power.

```
              33300
                  7
             ------
             233100
                  6
             ------
32·000) 1398·600·(44
        128
        ---
        118
        128
        ---
```

Answer, 44 horse power nearly.

TABLE SHOWING THE SQUARE INCHES CONTAINED IN A CYLINDER, OR CIRCLE, FROM TEN TO SEVENTY-THREE INCHES IN DIAMETER.

Diameter of Cylinder.	Square Inches.	Diameter of Cylinder.	Square Inches.	Diameter of Cylinder.	Square Inches.	Diameter of Cylinder.	Square Inches.
10	78·54	26	530·93	42	1388·59	58	2642·00
11	95·03	27	572·56	43	1452·20	59	2734·00
12	113 10	28	615·75	44	1520·53	60	2827·44
13	132·73	29	660·20	45	1590 43	61	2922·47
14	153 94	30	706 86	46	1661·91	62	3019·00
15	176 71	31	754 77	47	1785·00	63	3117·25
16	201·06	32	804·25	48	1809·56	64	3217·00
17	226·98	33	855 30	49	1885 74	65	3318·31
18	254·47	34	907·92	50	1963·50	66	3421·20
19	283·54	35	962·00	51	2042·82	67	3526·66
20	314 16	36	1017 88	52	2123·72	68	3651·69
21	346·36	37	1075·20	53	2206·19	69	3739 29
22	380·13	38	1134·00	54	2290 23	70	3848 46
23	415·47	39	1194·60	55	2375 83	71	3959 20
24	452·39	40	1256·64	56	2463·00	72	4071·51
25	490 88	41	1320·26	57	2651·76	73	4185 40

NOTE.—The annexed table of the quantity and weight of water contained in 6 feet of pump may be proved or extended by the followingrules; viz.

Square the diameter of the pump and multiply the product, first by the decimal ·7854, again by the length of the pump in inches, and divide by 281; the whole numbers in the quotient will show the wine gallons. Then, to find the cubic feet, divide the solid inches by 1728. Again, to find the weight, multiply the cubic feet by 1000, and divide the product by 16.

EXAMPLE.

How many pounds, wine gallons, and cubic feet, are contained in a cylinder, or pump, 12 inches in diameter, and 6 feet in length?

TO FIND THE WINE MEASURE.

```
                              12  12=144  Square of diameter.
                                  ·7854   Multiplier
                                --------
                                113·0976
                                       6
                                --------
                                678·5856
                                      12
                                --------
Cubic inches in a wine gallon=231) 8143·0272 (35·2512
                                                   4
                                              ------
        Answer, 35 gals. 1 qt.                1·0048
```

ART. II.—REPORT ON THE TUNUNGWANT COAL FIELD OF McKEAN COUNTY, PA. BY B. NEEDHAM, MINING ENG. AND GEOLOGIST.

McKEAN county contains 805,000 acres of land, two-thirds of which occupy a high table land some 600 feet above the Alleghany river. Of these about 125,000 ac. are underlaid with coal; of which latter quantity, nearly 75,000 acres lie on the north side of the Kinzua creek, and constitute a separate coal field, to which the name of the principal stream of the region, the "Tunungwant," has been given.

That portion of lands which I have examined, referred to in this report, comprises 27,545 acres with coal, and 14,083 acres without—making in all 41,628 acres.

These lands extend from near the town of Bradford, on either side of the Tunungwant creek, southerly, to Lafayette corners; thence westwardly to Hamilton township; thence northwardly to within two miles of the State line; and from thence to near the former town—being nearly all within the townships of Lafayette and Bradford. They occupy the centre of the largest coal field in McKean, and embrace twelve seams of coal, five of which are workable.

These lands give rise to, or are intersected by, many small streams, among the principal of which are the Tunungwant, Tunaette and branches, the Sugar Run, Turnip Run, Minard Run, &c., which have cut out most, and in many places, all of the coal measures, leaving the coal and iron ores of very easy access and mine drainage.

These lands are among the best in this coal field, and are favorably situated for mining and transportation; the railroad now being rapidly constructed, passes directly through them for nearly their entire length, offering great facilities for shipping coal, iron and lumber, while they are nearest to market.

From Marshburg, near the centre of these lands, to the New York and Erie Railroad, is nineteen miles; while the distance from the centre of the other basins east of Lafayette, is about forty-eight miles, as yet without any outlet.

As regards the lands south of the Kinzua creek, they are unquestionably as good as those on the north; but the Kinzua has cut down a deep gorge through the coal measures, which is impassable for railroads, without running round its head waters an average distance of at least eight miles. This extra distance will make a great difference in the value of coal lands. For instance, the freight and toll for eight miles of railroad, at 1½ cents per ton per mile, would be 12 cents; and as your coal lands average about 6000 tons per acre, it would cost to move the coal from one acre, of as good quality as yours, seven hundred and twenty dollars, to Lafayette, the most remote of your lands from market.

Now after deducting the interest on all lands not worked, it will be perceived that lands on the north of the Kinzua are worth much more than those on the south side, say 200 dollars per acre.

Pratically we find these figures have, for every mile in our anthracite coal fields, a great influence, and one which cannot be remedied.

The course of these basins is south 40° west and north 40° east, with a south-western dip of the synclinal axis of 12½ ft. per thousand, or about one degree.

The eastern and western dips are very gentle, varying from three to eight degrees, and forming quite flat basins.

As we approach the north-eastern terminus of this coal field, the measures are gradually lifted out, so that only one seam, very much thinned out, passes over the New York State line, and this is the only basin whose coal measures approach within ten miles of that line.

The mineral resources of these lands consist of bituminous and cannel coals; carbonate and black band iron ores, in great abundance; limestone; fireclays and mineral paints—(the red and yellow ochres)—and a comminuted quartzose white sandstone, suitable for the manufacture of the best flint and plate glass.

The surface is gently undulating and very well adapted to tillage, and most of it yet covered with a fine growth of timber, embracing white pine, hemlock, and most kinds of hard wood.

We were much assisted in obtaining the measurements of the stratification, from which our section is made up, by the numerous shafts, drillings, sidecuts, openings and other developments made under the supervision of Mr. Casey, assisted by Mr. Haffey, on these lands, and from which the measures have been more accurately and nearly all determined.

I have divided these lands into the large tracts by which they are generally known, without specifying each warrant, as being more comprehensive.

OF THE COAL.

The Marshburg Tract (embracing 3648 acres, purchased from the Fox & Ross Estate) contains 8000 acres, and is covered by eight warrants.

I have set the analyses opposite each respective seam of coal in the enlarged section, so it can all be seen at one view.

There are four workable seams of coal on these lands: the first of which, marked "G" on the section, is five feet thick, where opened quite pure, and without much slate. This will produce, according to the usual method of computing quantities, 5000 tons per acre; but the practical results of close scientific mining, would give 5,150 tons.

This seam underlies 950 acres of this tract, and will yield at least 4,750,000 tons of good merchantable coal.

It is proper to remark, so far as regards the analyses, that the

specimens taken for trial were obtained from the outcrops, where they have long been subject to deterioration and evaporation of their more volatile ingredients, and will not show as fine results as if taken from under a good mine roof.

The second workable seam on this tract is marked "E," on the section. This seam varies in thickness from 5 to 5½ feet, and is about half bituminous and half cannel, with 6 inches of slaty cannel. The bituminous and cannel interchangeably vary from 20 inches to 3½ feet in thickness, and the average thickness of each is about 2½ feet, the whole producing 5000 tons per acre. As Dr. Owen mislaid the specimens of the cannel part of this seam and had none to analyze, I give the one I have.

Moisture,	.62		
Volatile matter,	41.77	Total vol. combustible matter,	42.39
Fixed carbon,	46.45		
Ashes,	11.16	Coke,	57.61
	100.		100.

This specimen had been exposed outside an old drift, for many years, and much of the volatile matter had escaped, and therefore only approximates to its real qualities.

This seam underlies 1350 acres of this tract, and will yield 6,750,000 tons of coal, one half of which is cannel.

The next seam in the series is a cannel coal, and marked "D." It is two feet thick, with a floor and roof of carbonaceous shale, either of which is easily removed. We seldom estimate any vein of coal less than three feet thick, but from the very valuable product of this seam I think it will do to work.

The seam of coal known as the "Bog-head" of Scotland, and which has made, and is making, such a great change in the price of oil in England, is only ten inches in thickness, and with all its expense of mining is extremely profitable.

The Breckenridge coal seam, only twenty-eight inches average thickness, with a hard sandstone roof, and an indurated clay floor, costs a little over one dollar per ton to mine it; but is worked to a great profit; and I do not see why the "D" vein cannot be worked to advantage whenever the one above it shall have become exhausted. It underlies 6400 acres of this tract, will produce 2000 tons per acre—and yield 12,800,000 tons.

The lowest and best working seam in the measures of McKean County, is known as the "Splint," and marked "A." It is a fine bituminous coal, of lamillar structure, color black, and fracture rectangular. It is one of the varieties known in England as the parrot, or cannel; and is well adapted to the manufacture of iron, in its raw state; excellent for domestic use, and will work well in a locomotive without coking. It burns freely, has no appreciable amount of sulphur, little water, and leaves few ashes. It varies in thickness from four to five feet, in the different localities where it is opened, and will average on this tract 4½ feet—producing 4500 tons per acre; and as it underlies 7100 acres, will yield 31,950,000 tons: making a total on this tract of

40,075,000 tons of bituminous, and 16,175,000 tons of cannel coal.

The next tract, covered by parts of six warrants, embracing 1383 acres, and known as the "Farm Lands," is situated at and around Lafayette corners.

It contains five workable seams of coal of 21½ feet in thickness, besides slates, and six inches of slaty cannel.

The first working vein on this tract is marked "L" on the section, and is five feet two inches thick, with a thin slate, about an inch thick, leaving five feet of clear merchantable coal, of very good quality. This seam underlies 175 acres of this tract, produces 5000 tons per acre, and will yield 875,000 tons.

Next come some undeveloped strata, containing two seams of coal, as indicated by their outcrop, one of which is dug into a well at the village, and should be from 3 to 3½ feet thick, above which may be a limestone three to four feet thick; corresponding with one further south-east; but as they are not yet opened, and as the season closed on us so as to prevent us from farther extending our explorations satisfactorily, I have made no account of it.

The second workable vein on this tract is the "G" seam, which has heretofore been described, and which underlies 1030 acres—producing 5000 tons per acre, and yielding 5,150,000 tons.

The third seam in the series is the "E" vein before described, which underlies 1045 acres, works full five feet of cannel and bituminous coals, produces 5000 tons per acre, and will yield 5,225,000 tons.

The fourth workable seam is the "D" vein, which underlies 1164 acres of these lands, producing 2000 ton per acre, and yielding 2,328,000 tons.

The fifth and last seam is the Splint "A," which will average 4½ feet on this tract—producing 4500 tons per acre, and as it underlies the whole tract, will produce 6,223,500 tons, making 14,861,500 tons of bituminous and 4,940,000 tons of cannel coal.

North-easterly from Lafayette corners, and on the east side of the main branch of the Tunungwant, are the lands known as the "Minard Run" tract, covered by parts of nine warrants, and embracing 8547 acres.

This tract contains three workable seams of coal, the first of which is the E vein, to which a shaft has been sunk in, or near the outcrop.

This seam underlies 2345 acres of this tract, works 5000 tons per acre, and will yield 11,725,000 tons.

The second seam is the D, underlying 3500 acres—producing 2000 tons per acre, and yielding 7,000,000 tons.

The third and last seam is the Splint A. This underlies 4980 acres, and will average only four feet—producing 4000 tons per acre, yielding 19,9-0,000 tons—making 25,783,000 tons bituminous and 12,862,000 tons of cannel coals.

On the west side of the main stream of the Tunungwant, and extending from near Bradford village to within a short distance of and adjoining the Marshburg tract, is the large piece of land covered by thirty warrants, and embracing 23,698 acres, of which 14,082 are underlaid with coal.

There are but three workable seams on any of these lands. The "E" vein is the first on this tract, and underlies only 675 acres of the southern portion, the balance having been lifted out with the measures above, as you go north, and washed away. This will produce 5000 tons per acre, and yield 3,375,000 tons.

The second seam is the "D" vein, which underlies 2580 acres —producing 2000 tons per acre, yielding 5,160,000 tons.

The Splint seam A, the last in the measures, is thinned out to four feet on these lands. It extends over these lands and the State line, before it is all lifted out, and underlies 14,082 acres; the rest having been denuded and washed away, and cut out by the Tunaette creek and its branches. It will produce 4000 tons per acre, and yield on the whole 56,328,000 tons: making 58,016, 000 tons of bituminous and 6,847,000 tons of cannel coals.

These estimates are made up from the warrants in detail, after deducting all the mine waste, pillars, and slates; and I have been over them several times correcting errors first made, and I think you may with much confidence rely on the result.

Recapitulation.

The Tract of Acres	A	D	E	G	L	Tons of Bituminous.	Tons of Cannel.
8,000	7,100	6,400	1,350	950		40,075,000	16,175,000
1,383	6,223	1,164	1,045	1,030	175	19,701,500	4.940.000
8,547	4,980	3.500	2,345			25,783,000	12,862,000
23,698	14,082	2,580	675			58,016,000	6,847,000
41,628	32,385	13,644	5,415	1,980	175	143,575,500	40,824,000

II. OF THE IRON ORES.

All over this section of country a great superabundance of iron ores exists. There are two veins of silico-argillaceous carbonates, covering a much larger area of these lands than the seam of splint coal. There are also two deposits of nodular iron ore, and a belt of black band ore of very superior and unequalled quality.

This black band covers an area about equal to the "D" vein, and from its being found sixteen miles distant of similar quality, would appear to be persistent over quite an extent of country.

It is found on these lands five feet thick, eighteen inches of which is richer than any known in Europe, their best yielding only 36 per cent. metallic iron, and fourteen inches thick; while this proves, from several analyses, to contain 43¾ per cent.

The nodular ores over the A and G veins, as seen in the section, are of very good quality, containing, as per analysis, 42 per cent. metallic iron, and equivalent to a band of solid carbonate at least eighteen inches thick.

The two large veins of carbonates will work full 8 feet of clear ore, and, from the analysis of several specimens, yield from 31 to 39 per cent. metallic iron.

This gives eleven feet of workable ores, and as each cubic yard of ore yields iron enough for one ton of pig metal, the result would be 16,000 tons of metal per acre, after making liberal deductions for mine waste, supports, &c.

The Marshburg tract	would	yield in	round	numbers,	64,000,000 tons.
" Lafayette	"	"	"	"	22,000,000 "
" Minard Run	"	"	"	"	54,000,000 "
" Large tract	"	"	"	"	224,000,000 "

making ore enough for, say, 364,000,000 tons of pig metal, a quantity three times greater than all the coal and timber on the lands could manufacture.

As there are large quantities of hard wood timber on these lands, I think the most profitable purpose to which they could be applied, would be the manufacture of cold blast charcoal iron, —a kind in great demand, especially by the government, and which always commands the highest prices.

These lands all contain wood enough to make ten tons of iron per acre, including the hemlock timber, except the Lafayette farm lands and a part of the Marshburg tract. There is still wood enough on the latter lot to make

	70,000	tons	of charcoal	iron.
On the Minard Run tract,	85,000	"	"	"
On the large tract for	237,000	"	"	"

Making fuel enough for the production of 392,000 tons of charcoal iron, worth $36 per ton at the furnace. With the black band ore to mix with the others, a very superior quality would be obtained.

Persons unacquainted with the working of black band ores, would be very much surprised at the results obtained by mixing them with others. They increase the production of the furnace one-third, some say one-half, per week.

The presence of carbon, whether in chemical or mechanical combination, increases the fusibility of all ores, and when they contain even small portions of carbon and considerable silica, are smelted with greater facility and produce superior iron to those entirely devoid of it.

"If the quantity of carbon is large," says Truron, "as in the carbonaceous ores, the consumption of fuel is reduced nearly one-half, and the fusibility of the metal so great, that with the reduced consumption of fuel, the production is increased to nearly double the quantity which it is possible to obtain of as good quality, from the same furnace working on other kind of ores." See Truron on Iron Manufactures of Great Britain.

From the cheapness of mining the ores, and other facilities on these lands, I think iron can bo made for thirteen dollars per ton, and cold blast charcoal for fifteen dollars.

In reviewing the whole subject of the manufacture of iron in McKean County, its facilities to market, the cheapness of all the materials to produce it, &c., I cannot perceive why Lafayette and Bradford townships would not be very desirable locations for the erection of large furnaces, rolling mills, and other iron manufactories.

OF LIMESTONES, FIRECLAYS, ETC.

On these lands, lying below the coal measures, is found a limestone (the analysis of which is given) in sufficient quantity for all the purposes of agriculture and manufactures, and of reasonably good quality. The same may be said of the fireclays under the splint seam, and some smaller bands under the smaller seams of coal.

Below the limestone, occur two veins of a very good mineral paint, a red and yellow ochre; and there are several places where it can be very easily obtained.

OF THE MARKETS.

With the great mineral resources and the development of these lands, a market for the sale of their produce is of some importance, and a few remarks from me may not, in this connection, be out of place.

In the *locality* of these lands and their proximity to market, you are remarkably favored, as all the lands north of the gorge of the Kinzua are so much nearer market as to place them beyond the reach of successful competition from any other source.

McKean County must, from her position to the markets, and the superior excellence of her coals for gas, supply all northern and eastern New York, as well as the Canadas, for that purpose. On comparison of your coals with the average of all the English gas coals which show 3438 per cent. of volatile matter, and of forty-nine specimens of her cannel coals, 47 per cent., you will perceive from the analyses that your coals are superior to average qualities.

To make a good gas, satisfactory to the people of New York, I find they require a mixture of nearly one-half cannel with their bituminous coals; and your lands can furnish both kinds in quantities limited only by the demand. The erection of oil works on this property would be, perhaps, the most profitable disposition which could be made of the cannel coals, though much would depend upon their cost delivered in New York city. While cannel coals are worth fifteen dollars per ton for gas and domestic use (for which purpose a good deal is consumed) in New York city, the cost of delivery cannot much exceed

$6 50. This would leave a large profit on them; but, perhaps, not so much as could be realized by making them into oils, the expense of which would be about 16 cents per gallon,—the cost given by the Western Mining and Manufacturing Company, whose cannels yield 40 gallons of refined oil, 30 gallons of benzole, and 20 to 25 lbs. of paraffine per ton. From the specimens which I have seen and tried, of their coal, I find yours the richest, and I think you can reasonably rely on its being very profitable.

I think the greater portion of the upper seams of your coals will be disposed of for gas purposes, while the splint or lower seam, will be used in the manufacture of iron, domestic fuel, and for running locomotives, to which use large quantities must soon be applied.

Prof. Hall, State geologist, of New York, in his report on the McKean County coal field, says: "The geographical situation of this coal field, in the first place, gives it the advantage of some 100 miles of transportation over every other basin of any considerable extent. It has also the greater advantage in its short line of railroad to Buffalo, the most important point to be reached by the coal interest."

"Perhaps there is no city in America more favorably situated than Buffalo for vending the products of industry: with a surrounding country of unrivalled fertility; with the natural advantages of extensive lake navigation and the termination of the Erie canal,—there are no less than seven railroads which already, or soon will have, their termini at Buffalo.

"Pittsburg has been cited as an example of manufacturing industry. In 1825, Pittsburg consumed 35,714 tons of coal; in 1845 her consumption reached 464,286 tons, and now exceeds a million." What hinders Buffalo, with a larger population and more advantageous location, vieing with Pittsburg in her manufacturing industry, but the want of a cheap fuel?

In four years from the time the first train of coal cars reaches Buffalo, laden with the minerals of McKean County, the demands of the trade will require a million of tons per annum. From that time the inhabitants of that city may date their increased and permanent prosperity.

From thirty-one years residence in the anthracite coal fields of Pennsylvania, when in 1820 the markets were fully supplied with 365 tons, I have, from experience, acquired some knowledge of its past history and expansion, and I can with a little pretension to knowledge, judge of the prospects of its future developments.

Creeping along from 1820 with feeble force and infantile energy, we succeeded, in 1842, in bringing the shipments up to 1,108,418 tons. From 1840 may be dated the time when the coal business assumed system, health, permanence:

In 1845 the increase was nearly a million, viz.,	2,013,013 tons.
1848 brought it up to	3,089,238 "
1851 " "	4,329,530 "
1854 " "	5,831,834 "
At the end of 1855 it was over . . .	7,000,000 "

This shows the steady rate of expansion of the trade to be a little over a million in three years, and yet the trade is still in its infancy, comparatively; for all the coal mined and sent to the eastern markets on the Atlantic seaboard, including all the importations from foreign sources, from 1820 to 1855 both inclusive, a period of thirty-six years, amounted to only 61,156,965 tons. For the year 1855 England consumed and otherwise disposed of 64,453,000 tons; ten years before her consumption was only 30 millions of tons. Whence this great increase of the mining product of England in so short a time? It can only be accounted for by the great increase of her steam marine, and the usual increase of her mauufactures.

The whole mine product of coal for the world, was only 95,000,000 of tons for 1855. Being the second coal producing nation, our portion of that, including our western coal fields, was 12,335,000 tons.

The commercial tonnage of the lakes, of which Buffalo may be said to be the centre, is of itself of large dimensions, and it is computed that her daily consumption is about 1000 tons of coal. Nearly an equal amount would be consumed in her foundries, smithies, manufactories, gas works, and for domestic uses, if a supply could be furnished at reasonable rates. With a population of 90 to 100,000 inhabitants, the consumption of Buffalo may be set down at about half a million of tons per annum.

The cities and towns of Canada can be furnished direct from the port of Buffalo, in the cheapest and readiest way, with a full supply.

Much of these gas coals will find their way to Chicago, and other north-western cities, as the quality is so much superior to their own for that purpose. A few years ago, out of the Atlantic cities, gas was not used at all—scarcely known; now its use is limited to those towns which can get their coal to make it at more than double the price for which the gas coals of the Tunungwant field can be delivered. In two years from the opening of your railroad, all the towns and cities between the mines and New York, will be erecting their gas works and using these coals. These towns and cities, with the adjacent lake towns of Canada, containing over a million of inhabitants, can be reached either by railroad or canal, and their varied wants supplied by the coals from this field.

The Tunungwant coals can be sent to New York city, via the Genesee and other canals of the State, at a handsome profit —for the gas coals are very irregularly supplied to New York and other eastern cities, and at high prices; there is no source

where they can get their supplies so cheap and of as good quality, as from this quarter. New York draws the greater part of her gas coals from Pittsburg and Richmond, depending on the foreign supply for the balance, which is sometimes precarious, having in the winter of 1855, at one time, only six days supply, with the price up to $22 per ton.

In reviewing the whole railroad system of the United States, where there are over 5000 locomotives running, a demand is springing up, inevitable, unavoidable, and of the most imperious character, to supply this great system with cheap fuel; necessity is already forcing this subject on the consideration of all the various companies. A few details will suffice: north and west of the Chesapeake some few more than 3000 locomotives are running, requiring, at the usual rate of 80 cords per annum, 2,400,000 cords of wood; this is equivalent to 60,000 acres of woodland annually stripped off.

The salt works of Syracuse, alone, sweep 11,000 acres of its forests from its surface; five-eighths of the cost of which might be saved by the use of coal,—and bituminous coals work admirably in making salt.

To supply the farming interests and domestic wants of an agricultural population like New York, would denude from 10 to 20,000 acres more of its wood, and, with the Eastern States, make up 100,000 acres of woodland annually swept off. How many years can this state of things continue, even with wood at double the price of coal? Many of the roads are using coal with success. The Baltimore and Ohio use it both raw and coked. The New Creek Coal Company speak of it in their report as follows: "It is shown by the results that bituminous coal is 50 per cent. cheaper than wood, where the latter costs little more than the chopping of it." The Reading Road uses anthracite, with a saving of 5 cents per ton on their whole amount of freight. The experiments tried on the Illinois Central, in running a distance of 2310 miles with wood and coal, are as $115.50 for coal, and $389.32 with wood.

From the above considerations, and others that could be added, I am satisfied that our railroad system cannot be further permanently extended, nor much longer continued, without resorting to the use of coal. From the use of coal on our railroads as a fuel, may be dated a great increase in their usefulness: to themselves, by indirectly creating an additional business; to the public, by the employment of additional labor, the great increase of mine products and manufactures, and a fair reduction in the general price of fuel to the consumer.

Leaving further statistical details to the business man, and those more directly interested in this subject, I am satisfied that those who acquaint themselves with the vast commerce of the lakes, and the manufacturing interests of Buffalo and adjacent

cities and towns, must be favorably impressed with the importance, the permanence, and extent of the coal trade, so necessary to the wants and prosperity of so large a population.

Reviewing the great resources of your lands, the economy with which they can be worked, their proximity to a large market, and the excellent quality of coal with which to supply that market, one must become impressed with a belief in their great and increasing value.

Art. III.—ON THE GASES AND VENTILATION OF MINES, MORE PARTICULARLY CAVE MINES.*

It appears that the volume of air inhaled by a man is about 19 cubic metres in 24 hours, or 792 litres an hour. The volume of carbonic acid gas exhaled is about $\frac{1}{33}$ part of the volume of the air inspired; consequently a man exhales 570 litres per day, or 24 litres per hour of carbonic acid gas; and a litre being 0,264 gallons, the quantity of air inspired by a man is 209 gallons hourly, and the quantity of carbonic acid gas expired 6,336 gallons per hour.—(*Annales des Mines, first Series, Vol.* 10, *pp.* 45.)

According to Sir Humphry Davy and Dr. Henderson, about 5 cubic inches of azote are consumed every minute by an ordinary sized man. Allen and Pepys say that azote is given out by the lungs; and Ellis has labored to show that in respiration the natural azote of the atmosphere is untouched in quantity and unchanged in quality. The combustion of candles or lamps absorbs a quantity of oxygen which depends on the nature and weight of the substance burnt in a given time. There are at the same time produced carbonic acid gas and watery vapor.

The combustion of a lamp of the largest size employed in mines consumes less oxygen than the respiration of one workman. The oxygen of the air is also absorbed by the chemical decomposition of many substances which are ordinarily found in mines. Thus under the compound influence of air and moisture, sulphurets are transformed into sulphate, as in the case of iron pyrites, which we find transformed into sulphate of iron; and we know that vegetable and animal matters in the same circumstances undergo a putrid fermentation, in which the oxygen of the air disappears, combining with some of the elementary principles of these substances—the products being dissipated into the surrounding air. These are chiefly carbonic acid gas, carbonic oxide (?), gaseous compounds of carbon and hydrogen, azote and ammo-

* A practical Treatise on Mine Engineering by G. C. Greenwell, member of the North of England Institute of Mining Engineers.

nia. These gases are mixed with other substances which chemical analysis has been unable to isolate. They have usually a sickly odor, and exercise over people who respire them an action in the highest degree deleterious: they have received the name of Miasmata. The gases due to the chemical decomposition of certain substances are principally those which are formed by the deflagration of the powder employed in the works of the mines—varied most probably by the charge of powder, and perhaps also as it is more or less damp, and the combustion consequently more or less perfect, they form a composition of carbonic acid, azote, oxide of carbon, watery vapor, carburetted hydrogen and a little sulphuretted hydrogen. The solid products of the detonation, which are composed of unburnt powder, sulphate of potash, and sulphuret of potassium, are projected in very minute particles into the surrounding air, which is obscured by them. The fumes of powder, blasting powder especially, have a disagreeable odor, and irritate powerfully the organs of respiration; consequently it is indispensable to expel them by the prompt renewal of the air in the place where the blasting has taken place.

The gases met with in mines which when insufficiently diluted with atmospheric air are productive of deleterious effects upon the workmen, or capable of forming with it an explosive compound, are as follows:

1. *Carbonic acid*, called also stythe or black-damp.
2. *Byhydruret of carbon*, called also fire-damp, mixed occasionally with *hydruret of carbon, or olefiant gas*, according to some European authorities.
3. *Sulphuretted hydrogen*, rarely.
4. *Oxide of carbon?*

1. Carbonic acid consists of two atoms of oxygen and one atom of carbon. Its specific gravity, as compared with air, is 1.524; weight of 100 cubic inches 46.576 grains. Water absorbs nearly its own volume of this gas; caustic alkalies and alkaline earths absorb it very rapidly. It is unfit for the support of combustion and respiration. Atmospheric air, mixed with one-tenth of this gas, becomes unfit for the support of combustion, and lights burn badly in an atmosphere containing from 5 to 6 per cent.: air containing about 8 per cent. of carbonic acid cannot be respired without danger. This gas appears to act on persons who respire it in the manner of poisons; and it is necessary, in order to prevent its effect being fatal, that persons asphyxiated by this gas should remain in it a very short time: when they recover from it, they remain unwell, particularly with violent headache, for some days. Carbonic acid is frequently disengaged in mines from the fissures and cavities of the strata, and is formed, moreover, by the respiration of the workmen and horses, and also by the combustion of lights and deflagration of gunpowder.

On account of its great specific gravity, carbonic acid has a

tendency to accumulate in greater quantity in the low parts of all excavations, notwithstanding the general property possessed by gases, of intermixing or diffusing themselves throughout each other, when contained in any isolated space.

2. *Hydruret of carbon or fire-damp*, is composed of two atoms of hydrogen and one atom of carbon: its specific gravity is 0.555, and the weight of 100 cubic inches is 16.92 grains; it is insoluble in water, and is not absorbed by alkalies. When mixed with atmospheric air in the proportion of from 1-30th to 1-15th of the total volume, the flame of a candle plunged into the mixture is elongated according as the proportion of inflammable gas approaches 1-15th of the volume.

The flame of the wick is surrounded by a halo of pale blue, which is most perceptible towards the point. The combustion only takes place around the wick, and does not extend to the surrounding mass. When the fire-damp forms 1-14th of the total volume, the inflammation extends throughout the whole gaseous mass, but without loud detonation. The rapidity of the inflammation increases with the proportion of the inflammable gas until it amounts to 1-9th or 1-8th of the total volume: in these latter proportions the mixture is explosive in the highest degree.

If the proportion of fire-damp is increased still further, the mixture becomes less and less explosive; and when the mixture contains more than one-third of the volume of gas, it is no longer inflammable, but any flame immersed in it is, on the contrary, extinguished.

The contact of iron or coal at a red heat is not sufficient to produce the inflammation of fire-damp mixed with air: the presence of flame is necessary.

This, the generally received opinion, ought not to be too confidently relied upon, as is shown by the following experiment. The gas experimented on was passed through a drowned drift, and was conveyed by means of a pipe in the shaft to the surface; it then passed through naphtha into a gasometer, and thence to various burners in the shops and elsewhere.

There was also a cock between the top of the shaft and the naphtha vessel, whence, when opened, the gas issued in its natural form. The first experiment consisted in placing a bolt about two inches in diameter, heated to a cherry red, in contact with the naphthalized gas in the smith's shop.

The gas was immediately inflamed; in a short time, however, the iron, still at a good red heat, ceased to possess the power of exploding the gas. Precisely the same effects were produced when the iron was applied to the gas issuing from the cock between the pit and naphtha vessel.—(*Transactions of the North of England Institute of Mining Engineers, vol.* 1.)

Azote, or carbonic acid, added even in small proportion to an explosive mixture of air and fire-damp, weakens or even prevents

explosion; 1-7th of carbonic acid added to a mixture the most explosive, sufficing to render it the contrary. Bihydruret of carbon mixed with atmospheric air can be respired without danger, so long as it constitutes less than one third of the total volume; beyond this proportion, it causes asphyxia by insufficiency of oxygen.

Fire-damp is disengaged from the mud in marshes and from all stagnant waters, whence it may be easily obtained by stirring up the mud with a stick and placing an inverted bottle full of water over the bubbles as they arise. In some localities it flows from the fissures of the soil, and gives rise to natural fires, which exist in many places. Borings executed in exploring for rock salt have sometimes produced abundant jets of this gas.

But it is principally found in coal mines, escaping from the cells of this mineral with a slight noise, analogous to that produced by boiling water. It is generally disengaged in the greatest abundance in places which are in the neighborhood of vaults, near which the nature of the coal is altered. There are also in the interior of coal beds cavities where the gas is pent up under considerable pressure, and from which it escapes suddenly whenever the side of the cavity nearest to the workings is weakened by their approach, so as no longer to be able to withstand the internal pressure.

The following facts have been recorded of the volumes and pressures of gas yielded under circumstances of this nature—(Report on the Ventilation of Mines and Collieries, by John Phillips, Esq. F. R. S. pp. 8.) The first was experienced Nov. 13th, 1846: on this occasion, a mass of coal was displaced 8 feet long on one side, 4 feet long on the other, and nearly 6 feet high. This, with the disintegrated or danty coal which slipped from the dyke, must have weighed about 11 tons. A discharge of fire-damp ensued; the two men working the place secured their lamps (one of which had been partially covered with the fall of coal, but continued to burn; the other nearest the issue of gas had been put out), drew down the wick of that which continued to burn, hastened to apprise the other men in the pit, extinguishing the lamps as they proceeded, and finally retired to the shaft.

The extent of airways fouled at the same time contained about 41,681 cubic feet, and in from 15 to 20 minutes after the eruption there were no longer any traces of fire-damp. The air moved in this part of the mine at the rate of 6.24 feet per second, the quantity passing per minute amounting to 10.483 cubic feet. A second discharge of fire-damp took place on the 10th of December, 1846, at a different point of the same slip; in this case the gas came off from the danty coal with a violent noise, like the blowing off of high pressure steam, and fouled the air-courses for an extent of 641 yards in length, with an area of 86,306 cubic feet. The air was circulating at the rate of 5½ feet per second,

and the quantity was about 16,000 per minute. After 12 or 15 minutes all appearances of gas had ceased, excepting near the point of issue of the blowers.

According to Sir H. T. de la Beche and Dr. Lyon Playfair, the analyses of fire-damp obtained from several coal mines of the North of England, presented the following results:

	First.	Second.	Third.	Fourth.	Fifth.
Bihydruret of carbon	92 8	77 5	83 1	86 0	79 7
Nitrogen	6 9	26 1	14 2	12 3	14 3
Oxygen	0 0	0 0	0 6	0 0	3 0
Carbonic acid	0 3	1 3	2 1	1 7	2 0
Hydrogen	0 0	0 0	0 0	0 0	3 0
	100 0	104 9	100 0	100 0	102 0

The general result of this examination is, that the only inflammable constituent present in the explosive gas of these collieries is by hydruret of carbon. There is not a trace of olefiant gas, and only in one of the gases analyzed is there any hydrogen.

When bihydruret of carbon cannot be procured from its natural source, it may be obtained artificially by distilling in a coated glass flask at a red heat, the following mixture:

1 part stick potassa,
1 part dried acetate of soda,
1½ part quick lime,

all rubbed to fine powder and well dried.

It is necessary in this place to make some remarks upon the hydruret of carbon, or olefiant gas: it is composed of one atom hydrogen, and one atom of carbon: its specific gravity is 0.972, and the weight of 100 cubic inches 29.646 grains. It burns with a red flame, of which the illuminating power is much greater than that of bihydruret of carbon. A considerable quantity of this gas is contained in that obtained from coal by distillation (or common street gas), as appears from the following analyses by Dr. Henry:—

Constituents in Volume.

No.	Specific gravity.	Hydruret of carbon or Olefiant gas.	Bihydruret of carbon or fire damp.	Carbonic Oxide.	Hydrogen.
1	0 620	12	64 53	7 33	15 84
2	0 630	12	57 49	13 35	17 16
3	0 500	7	55 80	13 95	23 25

Common gas, from its mixture with olefiant and hydrogen gases, is much more inflammable than fire-damp, being easily ignited by iron at a low red heat.

It results from the analyses of Mr. Bischoff, of Bonn, that olefiant gas is mixed with the fire-damp of many coal mines—a

circumstance which has led this chemist to conclude that the inflammable gases of coal-mines are mixtures in different proportions, according to locality, of fire-damp, olefiant gas, and also of other gases in small quantity.

3. SULPHURETTED HYDROGEN.—This gas is characterized by the odor of rotten eggs. It is composed of one atom of sulphur and one atom of hydrogen: its specific gravity is 1.1805, and the weight of 100 cubic inches is 36.008 grains. It is soluble in water, which is capable of absorbing three times its volume of this gas; alkaline solutions absorb it rapidly: chlorine decomposes it by combining with the hydrogen, forming a deposit of sulphur. Mixed with air, it takes fire at the approach of flame, the products of the combustion being water and sulphurous acid.

When present even in small quantity in a gaseous mixture, it blackens the white oxide of lead and bismuth, which enables us easily to detect its existence. It is sufficient to expose to the mixture in which it is contained, slips of paper which have been dipped in a solution of acetate of lead and allowed to dry.

It exercises upon the animal economy an influence deleterious in the highest degree: a bird perishes in air containing 1-1500th part of its volume of this gas: the 1800th part is sufficient to kill a moderate sized dog (Thenard). The later researches of M. Parent Duchatelet would, however, seem to show that the poisonous effects of this gas have been somewhat exaggerated, at least in the application of these results to man. He observed that workmen breathed with impunity an atmosphere containing 1-100th part of sulphuretted hydrogen, and he states that he himself respired without serious symptoms ensuing, air which contained 3 per cent.

This gas is formed whenever sulphur in a very comminuted form is brought into contact with hydrogen in a nascent state. Thus it may form in mines where there is a decomposition of iron pyrites. It has been met with in old colliery workings, but its occurrence is rare.

4. OXIDE OF CARBON.—This gas consists of one atom of oxygen and one atom of carbon. Its specific gravity is 0.972; weight of 100 cubic inches 29.64 grains.

According to the recent work of M. Leblanc, oxide of carbon produces upon the animal economy an action more deleterious than that caused by carbonic acid. It burns with a beautiful blue flame, and gives out but little light; when mixed with common air it does not explode like fire-damp, but burns brilliantly: and from this circumstance it appears that a portion of this gas contained in any atmosphere might produce a compound in which a candle might burn brightly, but in which human life must be immediately extinguished; and I am very strongly of opinion that there exist instances of this nature, some fatal accidents having occurred, almost unaccountable excepting under this supposition.

From the properties of the gases above described, we may (excepting oxide of carbon) penetrate without danger into any atmosphere which we find to possess no disagreeable odor, which will not blacken acetate of lead, and in which a safety lamp will burn with facility; but as even under all these circumstances the atmosphere may, from the presence of oxide of carbon, be unfit for respiration, we are led to the one only practically safe conclusion, that we should, under all circumstances, be accompanied by a sufficient circulation of fresh air, the means of obtaining which I propose to treat of in the following order:—

1st. Natural ventilation. 2d. Artificial ventilation, *a* by waterfall, *b* by furnace, *c* by steam, *d* by machinery.

NATURAL VENTILATION.—When we have two shafts of unequal depth to the same level underground, we have a circulation of air established, the character of which will be as follows:—It will be remembered that there is a point where the temperature of the earth corresponds with the mean temperature at the surface, and that below this point the temperature increases with the depth. The consequence of this is, that we have a higher mean temperature, and a lighter column of air in the longer shaft than in the shorter one, at all times when the surface temperature is as low as or lower than the mean temperature of the mine. As the temperature of the atmosphere however increases, the difference of heat between the two shafts diminishes, and ventilation becomes gradually more and more feeble, until at length, when the two shafts become equal, it stagnates altogether. It may then happen (especially in pits of small depths) that the ventilation will be reversed, not indeed for any length of time, but only until that which has now become the downcast shall in its turn, by the introduction of the hot surface atmosphere, again become the warmer of the two.

In pits of great depth, however, where the temperature under ground far exceeds any mean, and even equals that of the hottest summer, natural ventilation may continue uninterrupted and of considerable power. The rationale of the motion of a column of air under such circumstances will be explained shortly.

Natural ventilation, however effectual it may be found in deep mines, having few ramifications, accompanied by freedom from inflammable or noxious gases, is quite inadequate to keeping in a safe and healthy state mines where these gases abound not only on account of its comparative feebleness, but on account of its liability (especially in mines of moderate depth) to be disarranged by changes of atmospheric temperature. We must, therefore, have in all mines artificial means at hand: in some, not perhaps necessary to be used at all times, but immediately applicable under any circumstances affecting the circulation of air produced by natural causes. This then leads us to the consideration of artificial ventilation.

Art. IV.—ON THE OCCURRENCE OF NATRO-BORO-CALCITE WITH GLAUBER SALT IN THE GYPSUM OF NOVA SCOTIA. By Henry How, Professor of Chem. and Nat. Hist., King's Coll., Windsor, Nova Scotia.*

The Natro-boro-calcite, to which the following communication chiefly refers, must be ranked among the least common of minerals, inasmuch as it has hitherto been found in but one locality, and is not yet fully described in the manuals of mineralogy. The circumstances under which I have lately met with it will add not a little, I think, to the interest it already possesses, as it has been obtained in a new geological position, and in a state of greater purity than the specimens as yet examined seem to have had, so that I have been enabled to make out its true constitution, which I believe, for reasons presently to be mentioned, has not till now been arrived at.

The brief history of the mineral is this. It was originally sent, a few years since, to Dr. Hayes of Boston, U.S., from Tarapaca, in Peru, where it had been found in the nitrate of soda beds. From the analysis of this chemist it seemed to be composed of water, lime, and boracic acid, and he called it hydro-boro-calcite. Ulex, however, examined a specimen from the same locality, and finding it mixed with the nitrate and sulphate of soda, he boiled the whole with water for the extraction of these, and, analyzing the residue, he expressed his result in this formula.

$$NaO\,2BO_3 + 2CaO\,3BO_3 + 10HO,$$

and he named the mineral Natro-boro-calcite. Professor Anderson, of Glasgow, afterwards analyzed a specimen from the same locality, which, though somewhat mixed with foreign matter, he showed to consist essentially of the mineral of Ulex. A few observations extracted from the paper containing these results,† will sufficiently mark the characters of the Peruvian mineral, and what is known of the geological nature of its till now unique locality.

"The Natro-boro-calcite is found in the nitrate of soda beds of the province of Tarapaca, in Peru, and is known to the natives by the name of Tiza. It occurs in rounded masses, varying from the size of a hazel-nut to that of an egg. Externally these have a dull and dirty appearance; but when broken across they are found to be formed of a series of interlaced needles of a brilliant white color, and silky lustre. These crystals were extremely minute in all the pieces I examined, but the specimen analyzed by Hayes was composed of prisms a quarter of an inch in length.

"The qualitative analysis indicated the presence of boracic

* American Journal of Science and Arts.
† Proc. Phil. Soc. Glasgow, Feb. 1858.

and sulphuric acids, lime, soda, water, siliceous sand, and traces of chlorine. Ulex found also traces of nitric acid, but that which I examined contained none.

"The quantitative analysis gave results according very closely with those of Ulex, excepting that previous to his analysis he boiled the mineral with water, to extract the nitrate and sulphate of soda which he had detected, and which are obviously a mechanical admixture. This was not done in my case, as the analysis was made for commercial purposes, and I was desirous of ascertaining its exact composition as it occurs. Ulex obtained:

	Expt.	Calc.
Water,	26·0	25·60
Lime,	15·7	15·93
Soda,	8·8	8·82
Boracic acid,	49·5	49·64
	100·0	100·00

which numbers agree very well with the formula,

$$NaO\ 2BO_3 + 2CaO\ 3BO_3 + 10HO.$$

The conditions under which this substance is found in loose masses in the nitrate of soda beds, give it a peculiar interest in a scientific point of view, and render it highly desirable that we should have full details of all the circumstances of its occurrence. The district of Tarapaca has been as yet but little explored, but it would appear that it is chiefly volcanic, and it is remarkable that up to the present moment boracic acid has never been found abundantly except in volcanic districts."

The rock in which I met with the mineral, in March last, is part of a very extensive formation of gypsum in the western centre of Nova Scotia, and the precise locality a bed of it at Windsor, on the Clifton estate, lately the property of Judge Haliburton. My attention was first drawn to the other mineral I have named at the head of this paper, the glauber-salt, as a curious "stuff" which had attracted the notice of the quarrymen, and which they called "salts." Upon the specimens of "salts" shown to me I at once saw that at least two distinct minerals were present, and procuring sufficient of both from the spot myself, I submitted them to examination. I give the chemical analysis in the first place, and afterwards the description of the minerals and locality.

The glauber-salt was easily separated in a pure condition, and its analysis in the fresh state gave,

Sulphate of Soda, ...	44·54
Water, ...	55·46
	100·00

showing that it was the ordinary mineral,

$$NaO\ SO_3 + 10HO.$$

The second substance reminded me of the Tiza which I had seen in the hands of Dr. Anderson, in Glasgow, and a careful selection of pieces being made, it was proved by the following results to be identical with that curious mineral. The water was found by gentle ignition, the soda estimated as sulphate in a portion of the dry residue from which the boracic acid was expelled as fluorid of boron, the other ingredients in a separate quantity, the boracic acid by deficiency. The whole results were calculated upon the *air-dry* mineral, which was always employed for analysis, and I obtained from the substance as it occurred:—

Soda,	8·36
Lime,	13·95
Boracic acid,	41·07
Water,	34·39
Sulphuric acid,	1·29
Magnesia,	0·04
	100·00

numbers which, notwithstanding the high percentage of water, showed me that I really had to do with natro-boro-calcite. Considering the two ingredients last mentioned as accidental, I treated a portion of selected mineral with *cold water*, washed well with the same, allowed the residue to dry in the air, and analyzed it. It was perfectly free of sulphuric acid, and gave of the other constituents,

	Exp.	Calc.
Soda,	7·21	7·82
Lime,	14.20	14·12
Boracic acid,	44·10	44·02
Water,	34·49	34·04
	100·00	100·00

The recurrence of the high percentage of water and the accordance of my experimental numbers, both from the purified and the actual mineral, with the calculated figures, are ample warrant, I think, for the following formula which I propose as the true expression for the air-dried natro-boro-calcite, viz.:

$$NaO\ 2BO_3 + 2CaO,\ 3BO_3 + 15HO,$$

which differs from that of Ulex, before given, by five additional atoms of water; these, I think it extremely probable, were removed by the manipulation with boiling, and possibly by desiccation at 212°. Indeed I found that when the air-dry mineral was placed in the air-bath at this temperature, it lost, upon separate occasions,

	I.	II.	Mean.
Water =	8·25	7·58	7·91 per cent.

which deducted from my total loss, above, leaves 26·49 for the amount retained, a number so close to that really obtained by Ulex—26—as to leave me little doubt that mine is the true expression. I find also that Hayes* originally gave thirty-five per cent water as the result of his analysis.

* Leibig und Kopp's Jahresbericht, 1849, p. 780.

The minerals just described were found in the closest association in narrow cavities, perhaps two inches deep, forming a kind of interrupted vein in the body of the solid gypsum-rock, exposed by blasting, about thirty feet below the surface, and extending horizontally some few feet. The more abundant mineral of the two was the glauber-salt, so far as I observed personally, but the quarrymen told me that at first the other came out in "bowlfuls," but they threw it away. I did not obtain more than a few ounces of the natro-boro-calcite, and perhaps not a pound in all was preserved by those who obtained it on this occasion.

The glauber-salt was perfectly transparent on the first exposure, and afforded a remarkably fine instance of the crystalline forms of the mineral, some crystals which I saw partially effloresced were at least 1½ inch in length. Many masses were penetrated by perfect crystals of selenite, of various sizes, simple and in macles.

The natro-boro-calcite was along with and among the crystals of the preceding glauber-salt, and in some instances the latter seemed to be crystallized upon the former as a nucleus, or possibly they were in definite combinations as a totally distinct mineral; for crystals which were at first beautifully transparent would effloresce after a day's exposure or less, and upon being placed in water show the silky texture peculiar to the Tiza, while plenty of sulphate of soda was to be found in the water. In other specimens, the natro-boro-calcite was alone in rounded mammillated masses in the substance of the gypsum; and these, which were of all sizes up to that of a pigeon's egg or so, on being broken, presented the appearance of a finely fibrous silky-lustrous mass brilliantly white in color.

The purest pieces had a specific gravity of 1·65; hardness =1; were tough between the teeth; tasteless; scarcely soluble in water; before the blowpipe, melted with ease to a transparent bead.

On comparing the circumstances of this occurrence with those referred to in the remarks of Professor Anderson, before quoted, and some other facts, I think they are very interesting. In the gypsum of Nova Scotia we have a new and distinct locality for the rare mineral natro-boro-calcite which is analogous with that of a species chemically allied,* boracite ($MgO\ BO_3$), found in the gypsum of Holstein, and a compact boracite forming beds with rock-salt and gypsum at Stassfurth in northern Germany.

With these exceptions, boracic acid is found, as is well known, either in directly volcanic regions, most abundantly as such or as borax, and a well marked case of actual sublimation of the acid, from a volcano in the island of Vulcano near Sicily, has been studied by Warrington;† or in smaller amount in

* Nicol's Mineralogy, p. 305. † Wells' Annual, 1856, p. 232.

minerals the products of recent or extinct volcanoes, as Humboldtite,* from ejected blocks of Vesuvius and zeolites, and Datholite from trap of Salisbury Craigs, New Jersey, and other places; or in minerals of purely plutonic or metamorphic rocks, as tourmaline, the rhodizite of Rose, and axinite; the species which contain it at all being few in number. It may be noticed also that traces of this acid have lately been met with in the Kochbrunnen of Wiesbaden,† and in the waters of Aachen.

If we may reason from the character of the majority of its situations, we may almost consider the volcanic or at least igneous origin of boracic acid so well established as to lead us by its occurrence in the saliferous strata to seek for some volcanic agency as the cause of their production.

Such an origin has already been assigned, I find, to the gypsum of Nova Scotia by Mr. Dawson.‡ This formation has been shown to be a member of the Lower Carboniferous series, and is assumed to have arisen from the action of rivers of sulphuric acid more or less dilute, such as are known to exist§ in various parts of the world, issuing from then active volcanoes, and flowing over the calcareous reefs and bed of the sea. In accordance with this view the gypsum is found only in association with the marine limestone, though, as might have been anticipated, these last sometimes occur without any gypsum.‖

Gypsum, which is geologically of very various ages in different countries, was supposed by the writer just quoted, to be peculiar to the Lower Carboniferous series in Nova Scotia alone, but it has been shown by Prof. W. B. Rogers¶ that a bed of this substance with rock-salt occurs in a thick deposit in limestone of the same period near New River in Virginia.

I think the occurrence of natro-boro-calcite in the gypsum of Nova Scotia cannot but lend support to the theory of Dawson as to the origin of this rock, when all the circumstances above mentioned are considered; and that a search for it or some equivalent in similar situations, might lead to more conclusive evidence as to the geological causes of the Saliferous systems in general, and furnish additional links of union between the sciences of geology and mineralogy.

* Nicol's Mineralogy, p. 307.
† Leibig und Kopp's Jahresbericht, 1852, p. 328.
‡ Acadian Geology, p. 228.
§ Lyell's Elements, Chap. xvi.
‖ Acadian Geology, p. 224.
¶ Edin. New Phil. Journ. Ap. 1857, p. 360.

ART. V.—ON DRIVING ADITS, AND THE MODE IN PRACTICE OF TIMBERING MINES. By WASHINGTON SMYTH.*

THE lecturer stated that, in previous lectures, he had pointed out the method in which lodes were generally opened; in these he had told them how, on several occasions, the capricious nature of the mineral deposits often deceived the miner. In driving a level they often experienced a great difficulty in keeping to the lode. The deposits were generally varying in character; sometimes they were rich, and at other periods they became poor and impoverished; often, in following the lode when it took a bend, the miners carried on a level straight with the anticipation of intersecting it at some further point. Very often the lode would split into small branches, and the miners, instead of following the main lode, would prosecute the working of these small strings until they were entirely exhausted. In large lodes, where this was generally the case, the miners often went not through the lode, but by the side of it, and at different distances drove cross-cuts, in order to obtain the ore. Several diagrams of lodes under different aspects were shown. Much depended upon the accuracy of measurement; and in one mine in Wales, where a shaft had been sunk to make a junction with an adit level, owing to a mistake in the calculation of a few feet, the mine was abandoned. In mountainous countries, and where there were valleys of great depth, it was always considered more advantageous to drive levels. In ancient times, where they had not sufficient machinery, and before steam power was known, and the amount of time not of much consideration as now, adits were more generally driven than they are at present. The Gwennap adit, though it is only at a depth of from 30 to 40 fathoms, has been considered of great advantage to that rich district, is from 30 to 40 miles in length. In several districts in the North of England, it is considered that greater facilities are given to workings by having adits. At Alston Moor it is common to look out for a valley contiguous to the mine, and some adits there are commenced at distances varying from ½ to 1½ miles from the mine. In Derbyshire, companies are especially got up for the purpose of driving adits, which are there technically called "soughs."

In Derbyshire, there is annually about 50,000 tons of lead raised. The mines there are not so symmetrically or continuously worked as in our western districts. The miners there descend and extract the ore at different periods, when not otherwise engaged. The water, that comes from the surface, so rapidly percolates through the rock, that it is nearly all dry, and the water runs off through the sough. The miners there are in

* Extracts from two lectures delivered before the Government School of Mines at London.

general so poor, that they have not capital sufficient to drive a sough for each mine, and companies are formed for the purpose of unwatering several, and these are paid by fixed dues from each. To a certain depth, the layers of limestone in the lead districts of Derbyshire were free from water, but beyond this the water rises rapidly, and, consequently, it was an imperative necessity they should have adits. At one mine, although they had used hydraulic pumps of from 30 to 40 inch diameter, they had not been able to fork the mine, so rapidly had the water risen. In many parts of the world these adits were very large. In the Hartz Mountains there was one which was used as a subterranean canal, and was navigated by boats. The deep George adit there (so named from one of our sovereigns) was 13 miles in length. There were several deep adits at Freiberg, in Saxony, and it was now proposed to drive one from the Elbe, in the district of Meissen, famous for its porcelain manufactory, a distance of 20 miles, in order to unwater the deep mines of that district; this would be about 20 miles in length, and had to be driven nearly the whole distance through hard gneiss. At Schmenitz, in Hungary, they were now driving deeper adits under the old ones. In the Alston Moor district they always endeavored to choose congenial strata for driving, as much time and expense would be spared by having a favorable rock to go through; if, after removing the gravelly detritus, they came to limestone, they were aware how much more costly that would be than if they went through shale or any thing of a similar nature. In railway tunnels, where time was an important object, they generally set a pair of men at both ends, and at distances commenced sinking shafts, in order that they might work several ends at the same time; this has likewise been done at the deep George shaft.

In the valley of Hodritsch, in the Schmenitz district, between the Zipser and Siglisberg shaft, the latter of which is productive, and the former only used for ventilation, there is between them a ridge of hills, about 1600 fathoms in length. A diagram was shown of the manner in which this long level is being driven, as well as the modes, by sinking winzes, of taking off the water and obtaining ventilation. In the Alston Moor district, great attention is paid to where the adit is to be placed, so as to secure it from floods, or in any way being inundated. In the mines of the Tyrol, where there is occasionally danger from avalanches, the miners endeavor so to place the mouth that it cannot be choked up by the falling of one of these destructive instruments of Nature. Boggy or marshy land should be avoided, as it must be borne in mind that the adit is not only for the purpose of unwatering the mine, but is likewise required for ventilation; and, if possible, the mouth should face the prevailing wind of the district, and great care should be taken to support the adit, so as to protect the men who are at work. One of

the greatest items of expenditure in mining was timber, and a due economy should be used in the exercise of this. Wood, larger than necessary, should never be employed. The amount of pressure cannot always be accurately told; this is different in large lodes, and where they are in a slanting direction; and here they require peculiar care in placing them. In purchasing timber, there are three great questions to be considered—strength of wood, power of resisting decay, and price; it should be of such a quality as to resist fracture, pressure in a vertical direction, or extension. When they had to deal with large mines, as in the colonies, Wales, and the coal measures, it was best to employ the timber of the district. In Cornwall, which was almost denuded of wood, the timber used was imported from abroad; several varieties of fur were used, spruce, as well as larch, this last being considered the best. The Scotch fir, *pinus sylvestris*, was not so much esteemed in Cornwall, although it was now in great favor in Ireland, and used there by Cornishmen, who it might be supposed would have a prejudice against it. Oak was generally considered the first as regarded strength and durability, and small poles of it were used for prop wood. Beech and birch had been made available in mountainous districts, but had been found brittle. In some of the southern countries of Europe, Spanish chestnut was known to answer. Interesting experiments had been tried in the French coal mines, on the respective merits of acacia and the black and white oak, and the result had been greatly in favor of the acacia, this having stood for a considerably longer period than the others.

A section of a mine was exhibited, which, instead of being in lines, as is generally practised in England, showed where the lodes had been rich or poor, where they were timbered or arched, as well as the strata through which they had passed. One of the works he could recommend to his pupils was that of Mr. Sopwith, on isometrical perspective, this being very useful to the student. The lecturer concluded by pointing out the necessity of working, not only with regard to the rules that might be defined, but to make available all the local advantages that presented themselves in pursuing mining operations.

ON TIMBERING MINES.

The lecturer observed how necessary it was for those who were intrusted with the management of a mine to be able to ascertain the quality of the timber they were about to apply. It was requisite they should have a due regard to its price as well as strength, and that no more should be employed than necessary for the purpose intended; and in general, in our metalliferous mines of Cornwall, this seemed to be well understood, and practically carried into operation. The mode of timbering a mine must much depend on the locality and aspect of the dis-

trict. At the salt mines of Hungary, where there was a great pressure of rock-salt, they adopted a mode quite different to that practised in our metallic mines: there the timbers were placed close together, and the mode of supporting the levels there cost as much as £2 12s. per fathom; where dangerous, and where they were obliged to have recourse to dovetailing, or mortising, the cost could be calculated at £5 per fathom. Timber of a small size was used where a level was driven through a lode in inclined strata. In certain metalliferous deposits, instead of vertically, you had to go down to a certain angle: this was the case in several tin workings and flat work; and in the district of the Ruhr it was at a most inconvenient angle. This was obviated by two stanchions and a cap-piece, and then filling up with attle, to support the level. In some cases the gallery was made larger, for the purpose of the circulation of the water; but there were certain rocks in our own country where this would be perfectly inadmissible. One great point they would have always to consider was the safety of the workmen employed. In some cases the ground was perfectly secure at the time of removal, but required immediately afterwards to be looked to, or else the lives of the people would be endangered. There was a great difficulty in driving through decomposed granite or friable porphyry: not only did the miners require strength and endurance, but likewise it was absolutely necessary that a considerable amount of judgment should be exercised. And here he would impress upon the students the necessity of studying the plans, and drawing according to scale the machinery, sections, plans, &c, and appreciating them upon every occasion. To the drawings they should pay particular attention. The dimensions of the gallery or level should be considered, as well as the nature of the strata to be driven through. A diagram was then exhibited of a level driven through friable granite, and owing to a want of knowledge of the strata, and absence of proper precautions, had fallen in, and, consequently, the cost was more than three times multiplied what would have been the expenditure had the requisite amount of judgment been brought to bear. Several instances of the mode of timbering the sewers were then given, as well as the modes of so doing in military mines, in the various-kinds of strata they had to go through.

In France, Westphalia, and Belgium they often had to drive through loose ground: at this period much attention and great interest had been drawn to the coal basin of London, and a considerable quantity of running ground could be expected. On the Continent these beds were called Tourtia. A small opening would suffice to fill the levels with sand water. In Belgium, many of the workings had to contend with this quicksand; and if they drove the level at the same size it was commenced, the lives of the men would be endangered. To avoid this, they

drove out smaller levels, with headings, until they approached near the dangerous ground, in order to be able to tap off the water, which is more than half the danger.

Several levels have been driven on a large scale; some of these have been used for the carriage of materials, &c.; in these cases masonry, or something subsidiary, has been used. Models were then shown of breast-work, and the modes of protecting levels in case of a run. If proper attention and diligent capabilities were brought into action, the system of using breasting boards might in general be considered secure; but, at the same time, it was slow, and very expensive.

In many of the levels, where they had to work through these quicksands, they were obliged to extract, in consequence of the runs, a great deal more ground than they had to go through. The lecturer then alluded to the Thames tunnel, citing the instance of Richard Trevithick: how he had gone 930 feet under the river, and on encountering a muddy hole, which he stopped, he carried on the operations until he had reached 1000 feet. There he was to have received some reward from the corporation. A dispute having arisen between him and the surveyor as to about a foot, he made a hole in the roof of the tunnel at low water, in order to show that he was correct, totally disregarding his own interest or that of the shareholders. And previous to his being able to verify this, the water rushed in. He was the last to leave the place, showing a great instance of moral courage. Subsequently, Brunel, who carried the tunnel successfully to an issue, had used the shield which had been so secure; in this were thirty-six compartments, and the miners were followed by the brick-work of the masons.

In the mine of La Louvieres, in Belgium, they had endeavored to drive a level, and he would be particular as to data, as it was a most remarkable case. This was commenced in the year 1747, and up to the year 1843 they had progressed so slowly that they had only advanced 1150 yards. At every yard they had excavated, owing to the run of the quicksand, they had to throw behind them from 40 to 45 cubic yards of sand, and they would thereby see what an immense amount of toil and labor this must have cost. In 1844, a miner of the name of Durieux had introduced a new method; and this was by driving wedges, successively, one after another, through the face of the level. A diagram was shown of the cap-piece, as well as the sidings, and the sole. At first they were only able to accomplish from one yard to four feet per week, but ultimately, as they progressed, they were enabled to advance as much as three feet per diem.

ART. VI.—THE EFFECT PRODUCED UPON BEDS OF COAL BY WORKING AWAY THE OVER OR UNDERLYING SEAMS. By MR. GEORGE ELLIOT.

FROM practical observation in the management of various extensive collieries during several years, I discovered that extraordinary phenomena were presented by the working away in different rotation seams of coal when overlying one another, and at various depths from the surface.

I shall endeavor, and as briefly as possible, to state the different effects I have found produced upon the underlying seams of coal where the upper seam has been first worked out, and shall, therefore, confine myself to a description of the phenomena exhibited in three mines, at the different depths of 80 fathoms, 180 fathoms, and 280 fathoms from the surface, and where the mode of working had been precisely similar.

I propose to deal with the deepest first, viz., the Monkwearmouth Colliery, where my attention was first arrested by what appeared to me a most extraordinary and unaccountable phenomenon. At this colliery there are two workable seams, the Maudlin seam, at a depth of 265 fathoms, and six feet thick, and the Hutton seam, at a depth of 285 fathoms, and four feet thick. The former seam had been worked several years previously to the latter being sunk to, but chiefly in the whole, leaving large pillars of thirty yards by forty yards, with a five-yard bord, in fact only taking away about one-eighth of the coal, leaving seven-eighths for the support of the roof. A considerable number of these pillars were afterwards removed, and a large goaf made. During the formation of this goaf, and when it was about twenty acres in extent, a circumstance occurred which I here mention, as it may probably tend to throw some light upon the subject under consideration, which was as follows: On one occasion there was a heaving of the bottom and a fissure opened from which a large quantity of gas issued, making a noise similar to the escape of high-pressure steam from a boiler: the gas ignited at a candle and burnt some of the men. Some time after this the pit was sunk to the Hutton seam, which also became extensively worked. Generally the coal in this seam was very easy to work, and produced, in the ordinary working, fifty per cent. of small, through a screen the bars of which were five-eighths of an inch apart, notwithstanding the coal itself was hard and strong, singularly so considering the large percentage of small produced. The roof of the mine was uniformly bad, and required a very large quantity of timber to support it, and labor to keep the main ways open. The coal, in course of working, would not stand to be kirved for juds, (technically termed);

when kirved it burst out at every blow of the pick with a crackling of the coal, and the top part of the seam thrown or fallen down as the kirving advanced.

The mine at this enormous depth was at a temperature of 77° Fahrenheit, and exceedingly free from carburetted hydrogen gas, so much so that it was the custom to drive the bord forty yards to the pillar, and the wall thirty yards further, without brattice, and with the naked candle. The heat was such as always to induce a natural ventilation, by maintaining a current of air, which always passed down by the floor of the mine and returned by the roof. I have frequently seen this natural current so strong that it made a lighted candle "swale."

In the progress of working the Hutton seam, the workings advanced to the district immediately under the goaf in the Maudlin seam; and at this point, throughout the whole area, where the coal in the Maudlin seam had been entirely taken away, a most remarkable change took place in the Hutton seam coal. It became hard to work, there was no crackling or bursting out attending the working of this district, and it could only be worked by the use of gunpowder. The coals wrought were very much larger, and a considerable diminution in the percentage of small (not less than twenty per cent.) was the result. The roof was strong and scarcely required any timber to support it; in fact it was quite like another pit, and the coal, even when worked in the broken or pillar working, was still hard and strong.

The next example I have to give is at Usworth Colliery, where there are three seams of coal in course of working, viz., the Hutton seam at a depth of 175 fathoms, the low main 165 fathoms, and the Maudlin seam at a depth of 155 fathoms from the surface. These seams were simultaneously worked. The system of working then adopted was, in the first instance, to work the upper or Maudlin seam, the low main next, and the Hutton seam last. It was, however, found that, in the course of a few years, as soon as either of the two lower seams had in the course of working arrived where either of the two seams above had been taken away, the coal under these goaves became so hardened and bad to work, that it became a difficulty to induce the men to work the coal, especially in the Hutton seam, which, under ordinary circumstances, was a very tender, fragile coal, from its want of size unfit for household purposes, and therefore best suited for gas or manufactories.

In this mine there is a large production of carburetted hydrogen gas, rendering the general use of candles and powder unsafe; and although in some instances double the amount of score price was paid for working the portion of coal under the goaf, yet it was found insufficient to compensate the workmen for hewing it, and it became a question how the seam was to be worked at all.

After struggling for a considerable length of time with this difficulty, before I had arrived at the conviction of its cause, (which was only done after repeated instances of the same effects), and observing that though the coal did not make the hissing noise, yet there was a considerable quantity of gas remaining in the hard places, I was obliged to change the system of working this colliery, which was to reverse the order of working hitherto observed, by stopping the upper seams and advancing the lower, so as to work the coals entirely out in them before approaching with the workings in the upper seams.

My underviewer, Mr. Cole, explained to me that in working the lower seam under a goaf in the upper seam, that had been laid down at Jarrow colliery several years ago, a similar result had been met with, which to them seemed unaccountable.

The third instance I now give of the working seams of coal in a similar manner, at a less depth, viz., 80 fathoms from the surface, is from the Marchioness of Londonderry's collieries. A great extent of the coal there is at that depth, and has been worked extensively in the manner described in the several former instances; and there, as well as in many other similar cases, seams of coal have been worked under my direction, without appreciably showing any of the effects which have been so strongly evidenced in those mines at greater depths.

The foregoing are a few of the striking results which I have observed in working seams of coal, where the coal in the upper seam had been taken away first.

I shall now proceed to give a few instances of the effects produced on upper seams by the working of the seams immediately below them.

The old-fashioned system of working coal in the North of England was in what was called the whole, leaving pillars of adequate or supposed adequate strength to maintain the roof; and not unfrequently this has been done over a considerable area in three or four seams, the quantity of coal taken away being about one-third, leaving two-thirds. This condition of a colliery renders it very puzzling to the viewer to decide which is the best mode of working the remaining two-thirds, without occasioning considerable loss of coal by creating creeps, which indeed is almost impossible. If the course of working the pillars in the lower seam is decided upon, as soon as this is done extensively, the subsidence of the roof by the removal of the coal, disturbs the pillars in the upper seams, and a creep is almost inevitable. On the other hand, if, perhaps, the safer course be adopted and the upper seam is taken away first, then the violent falling in of the roof frequently occasions considerable injury to the seam immediately below it, damaging the air-courses, wagon-ways, &c. The injury, however, does not always extend in the same degree

to the seams below, and I am, therefore, inclined to think that when seams of coal are so situated, all standing in pillars, more merchantable coal can be obtained by working the higher seams first and so downwards.

The improvements of mining science and practical experience will henceforth, I have no doubt, prevent the future occurrence of the condition of things I have just referred to. Modern practice has decided that to leave large areas of pillars, is neither so economical in the working of a colliery nor so safe against accident. The approved practice now being either to work the coal by means of long wall or by large pillars, removing them simultaneously with the working in the whole coal. Again, we have the system of working the lower seam entirely out first before entering the upper seam. This is frequently done without either much inconvenience or injury to the seam above, although frequent breakers or fractures come up from one seam to the other, when the chief difficulty is to deal with the gas that ascends from the lower seam; this, however, to my knowledge has never been found insurmountable, nor do I think that generally the working expenses of the upper seam are much increased, nor the percentage of small, neither is the size or quality of the large coal materially injured by this mode of working.

In many parts of the country there are certain covenants embodied in colliery leases which prescribe that certain of the seams demised shall be worked first, and shall be worked in a certain manner. From a full consideration of the subject now under notice, it cannot fail to strike every one present, how difficult it is to lay down any fixed rule or system which would guide to the most effectual working of a series of seams of coal, as the two examples I have given at Monkwearmouth and Usworth Collieries most clearly show, that while in the former the working away the upper seam first improved the seam below in every respect, at Usworth the same rule applied rendered the lower seam almost valueless, and at collieries of less depth there is no appreciable effect produced.

Assuming that the phenomena witnessed in the instances cited will prove to be universal at those depths, it would require the mode of working to be varied to suit the circumstances of each case; still it is a most valuable discovery if it should, as I have supposed, affect the whole area of a royalty in the lower beds of coal, by the first working the upper seam (my observations have hitherto been confined to an area not exceeding 30 acres), and a great principle will have been ascertained and established, viz.: that the lower seams are improved in hardness, in yield of merchantable coal, the roof improved, and all the incidental work, except the hewing, economized by the system.

It will then become a question for practice and further expe-

rience to determine if it will not be the better way of working collieries, especially of great depth, by excavating the upper seam first, although as a rule the coal is not so strong, and yields more small coal than the same seam of coal would do at a less depth, and, although it might not in itself be so remunerative to the owner to work, still I conceive that the advantage gained by the improved value of the lower seams would fully compensate for the diminished profit on the upper seam. The peculiar result and disadvantage from working the upper seam at Usworth Colliery first will prove to be exceptional, and applicable only to similar situations where the coal is not required to be worked large, and where the use of gunpowder cannot be adopted.

Upon a careful review of all the circumstances arising out of the consideration of this interesting subject, I am of the opinion that it will prove to be of permanent advantage to deep coal mines to work the upper seams first, and to improve the lower beds in hardness.

ART. VII.—ON MINING SURVEYS.* By ARTHUR BEANLANDS.

THE object of the present paper is to direct the attention of the members of the Institute to certain improvements which I have recently introduced in the practice of Mining Surveys.

It will not be necessary for me to say any thing respecting the value and importance of accurate surveys of the workings of collieries and mines, and I think it will be generally admitted that a great proportion of colliery plans do not possess such a high degree of accuracy as might be desired. It seems also not unreasonable to suppose that the deficiency in this respect is owing, in a great measure, to a want of precision in the instruments and methods generally in use.

The plan which I have now to explain, is one which, I believe, will answer perfectly well in the great majority of collieries, if not in all. After much study of the subject, and actual trial of the method, I have been led to the conviction that it possesses a high degree of accuracy for all practical purposes, and is decidedly superior to any other system which has come under my notice.

The leading feature of this plan consists in a method of fixing a bearing or meridian line at the bottom of the pit, the direction of which is determined, either with reference to the true meridian, or with respect to some line arbitrarily fixed on the surface. By this means the underground survey can be commenced, and car-

* Transactions of North England Institute of Mining Engineers. Vol. IV.

ried forward to any extent, by means of the theodolite, and is properly connected with the surface, the whole process being thus effected without the aid of the magnetic compass.

This method of determining the bearing is my own invention, or, at least, I am not aware that the idea has ever been carried out before, or has even occurred to any one else, though, of course, it is quite possible that I may not be the first person who has thought of such a plan.

The process, which I will now describe, is effected by means of a powerful transit instrument, mounted in the line of the shaft, either at the top, or bottom, as may be most convenient. For simplicity, I shall, in this description, suppose the instrument to be at the top of the shaft. It is fixed and properly adjusted on a very firm support, which must be so constructed as not to interrupt the view of the telescope, when pointed vertically down the shaft.

Two marks are then fixed at the bottom of the pit, as nearly as may be in the same vertical plane as the transit, so that each of them can be seen through the telescope, and appears nearly in the centre of the field of view. These marks are rendered visible at the top, by the light of a strong lamp reflected upwards, and are likewise so arranged that both can be seen by a theodolite placed at the bottom in a horizontal line with them. They are made as small as will allow of their being seen and observed by the transit at the top, and are of such form that they can be bisected by the wires with great precision.

The position of the instrument and of the marks is arranged to allow the latter to be as far apart as convenient, so that both marks can be seen through the telescope at the top.

If now, on pointing the instrument downwards, each of the marks appears exactly bisected by the middle wire, it is evident that the horizontal line, in which the marks are placed, coincides with the vertical plane of the instrument, and is, therefore, parallel to the position of the telescope when pointed horizontally. In this case, therefore, we have two lines, one at the top of the shaft, represented by the optical axis of the telescope when printed horizontally; the other, the imaginary line joining the centres of the two illuminated marks at the bottom; and the bearing of the instrument being determined, either with reference to the meridian, or to some determinate line which can be connected with the surface survey, that of the line of direction of the marks below is ascertained at the same time.

This, however, is on the supposition, that each of the marks is seen precisely in the centre of the telescope. If this condition is not exactly fulfilled, the marks being a little out of the centre of the field of view, the apparent distance of each mark from the middle wire is accurately measured by a micrometer, or some

other means, and from these distances, the angular deviation of the line of the marks from the plane of the instrument is determined by calculation. Having found the amount of this deviation, the bearing of the line of marks is at once deduced from that of the instrument

Hence, in this case also, as well as in the other, we have the means of connecting the underground survey with the surface plan.

It is necessary, in order to complete the process, that permanent marks should be fixed above and below, the marks aboveground being set out in some given direction with respect to the plane of the telescope; those below, with respect to the illuminated marks, which, as well as the instrument, must be removed from their places in the line of the shaft before the colliery can resume working.

Wherever the nature of the ground or erections on the surface admit of it, marks may be placed at once in the direction of the instrument above, being set out in any convenient positions, coinciding with the middle wire of the telescope. These permanent works should of course be placed so that one of them can be seen from the other; it is also desirable to have them conveniently placed for the commencement of the surface survey.

Where, however, it is not practicable to set out a line in the direction of the transit, owing to obstructions, some other direction must be taken, one mark being fixed in the line of the instrument, and the other at any point at a convenient distance, and visible from the first. The direction of the permanent line will, of course, be determined with respect to that of the transit, by setting up the theodolite at the nearer station, and measuring the angle between the direction of the transit, and that of the further station.

The permanent marks at the bottom of the pit are fixed in like manner, and their direction determined from that of the illuminated marks, by the aid of the theodolite, which is placed at some point near the shaft, in the line of the illuminated marks, and from which a more distant point can be seen. A permanent mark is then fixed at the place occupied by the theodolite, and another at the more distant point referred to, which may be chosen convenient for the commencement of the underground survey.

I have thus endeavored to explain, somewhat briefly, but I trust with sufficient distinctness, the method by which the underground survey is connected with the surface. It will scarcely be necessary for me to observe that the whole process is one requiring great care, and an intimate acquaintance with the use and manipulation of the instruments, such as can scarcely be acquired without considerable experience. With proper management, however, and a transit of sufficient size and power, I believe the

bearing may generally be fixed at the bottom of the pit without any error exceeding one minute of arc, a degree of precision amply sufficient for all practical purposes.

I shall merely add a few remarks respecting the mode of carrying forward the underground survey with the theodolite.

As the workings of collieries are frequently very extensive, and cannot be surveyed without a great number of lines and angles, the stations often occurring at very short intervals, it is obviously a matter of great importance that we should, as far as possible, avoid committing errors in the process of changing the instrument from one station to another. This is effected very completely by the following method pointed out in "Williams' Practical Geodesy." Three pairs of legs are provided for the theodolite, and each of them is so contrived that a lamp or some other convenient object can be placed upon it exactly in the position occupied by the centre of the instrument. Thus, on removing the theodolite forward, the lamp in advance and the instrument are made to change places without disturbing the legs, two pairs being always kept fixed while the instrument is changed, and the third pair moved from the back station to the new one in advance. By this means the errors to which I have referred may be rendered almost insensible.

I have thought it proper to mention this mode of using the theodolite, as I believe it is not very generally understood, although it is by no means new. I consider it of great importance in practice, and have proved the value of it by actual trial. Without this improvement, the utility of the instrument is very much lessened in underground surveys, both with respect to accuracy and convenience; but with this contrivance, and the usual precautions against error, which will at once suggest themselves to every one familiar with the instrument and acquainted with the elementary principles of geometry, I consider that for the purposes of an under-ground survey the theodolite may be regarded as perfect.

Art. VIII.—IMPORTANCE OF MINING EDUCATION.*

The lecture, introductory to the course for the next session, was given by Mr. M. Fryar, on the "Importance of Mining Education."

The education of miners was a subject to which, of late, very considerable attention had been induced, by the impression that

* Bristol Mining School.

the number of accidents arising from explosions of fire-damp, and other causes, would be considerably lessened thereby, the money value of mining very much increased, and a superior moral tone and mental bias given to the character of the working miner, who, in common with many others, was, alas! but too often the victim of brutal habits and passions. What education was likely to do for the miner in a moral point of view, by awakening in his mind ennobling thoughts, and bringing into due exercise his intellectual faculties, so as to discover to him a clearer notion of his being, it was likely to do for others; but the purpose of the lecture was to give prominence to those advantages which miners had over others in the study of particular branches of education, and to show why it was of greater individual and social importance that the miner had an acquaintance with these branches than people generally. No one could deny that a knowledge of geology was of greater importance to the man, whose daily occupation was several hundred feet into the earth's interior, than to one who seldom or never descended a foot below the surface. The very fact of the coal being found where it is, with certain kinds of rock superincumbent and sub-lying, was one of geology. How blind the ignorance, and how limited the thoughts of the man who ignored all notion of the probable limit, form, and origin of the very valuable and important mineral with which he daily had to do! Constant empiricism made him familiar with its appearance, and some of its properties; but, while he plied the pick or used the shovel, his cogitations were ever fast bound to the place of operation, or to some subject most probably more trivial and less improving.

"No country (said Prof. Ramsay) had produced so many men eminent in geology as the British Islands. Though not the birthplace of geology, it was here that it had been fostered and reared to its present goodly stature." The same writer truly remarked that "merely the alphabet had been yet discovered, and but some of the inscriptions graven on the rock deciphered, and that many readings were wanting, and many passages obscure." The time is still early; the subject is but opening to view, and its revelations are boundless. If we had but one ardent student of geology in each of our mines—one who could read the "testimony of the rocks," submit his observant mind to the truths which geology is ever ready to reveal, and append the facts thus obtained to the already extensive records of geological research, what an impulse might be given to the science, and how many and important truths would, in all probability, be brought to light! Each colliery might then become a sort of text-book in geology for the locality in which it is situated, and almost every collier become an abettor and promoter of the science. The value of this kind of knowledge to mining speculators and managers was sufficiently obvious from the following:—It was said that "near Tiverton,

in Devonshire, a shaft was sunk in the shales of the millstone grit. In vain was their endeavor after coal, till one Sunday, when the population were safely housed in church, some boys emptied a coal-scuttle into the pit and on the top threw a part of the extracted rubbish. Great was the joy on the Monday morning, when the miners brought up the coal; it was declared to be as good as Newcastle—which indeed it was—and all the parish bells were set ringing!" "In the coal fields of the Forest of Dean, the carboniferous limestone shale lies 6000 feet below the lowest bed of coal; nevertheless, in Herefordshire, a person more confident than sagacious, first built his engine-house and sheds, to receive the produce, and then boldly sunk a shaft in these beds in search of coal, where it could not by possibility exist." Instances allied to these were undoubtedly of more frequent occurrence than was generally supposed; for how could it be otherwise, where ignorance of the geological facts so essential to success in mining enterprise so extensively prevailed. A useful knowledge of mineralogy, at least all the minerals met in coal mining, might, with a little trouble, be obtained by the working miner; and if in possession of this knowledge, he would be in a fair way of detecting the presence of new minerals, and instituting inquiries after their properties and importance; the result of which might perchance be a clearer lustre to the light of science, an additional profit to both master and workman, and a blessing to the world. And who so favorably circumstanced for the successful and practical pursuit of this study as the working miner? Who so likely to dig out of Nature's volume treasures new and old in this respect; besides which, to know of the presence of certain minerals, and something of the circumstances under which they were formed, is to be able to account for many of the phenomena of strata, otherwise mysterious, and to anticipate changes in the working vein or seam, either favorable or otherwise.

The study of mechanical science was one of such vast interest and utility to miners, above most other classes, that for the miner to become familiar with some of its teachings was to be able to make something like one-fifth more money than he could do otherwise. It would teach him the shape of the mallet, the most effective kind of pick, the best form of wedge, and where it must be placed to produce the greatest effect, and how the coal might be most easily prepared to aid this effect. There was no question but what, in many instances where the coal was blasted, the young hewer lost more by his disregard through ignorance of the line of least resistance than would have paid for him six months' education, or furnished him with a valuable addition to his library. The lecture proceeded to show that the same applied to the setting of timber, laying of tramway, erecting brattice, &c. Also, the importance of the miner having some acquaintance with chemistry and other branches of natural philosophy.

ART. VIII.—ON BOILER EXPLOSIONS. By MATTHIAS DUNN.

THE explosion of boilers has now become as exciting a subject as the explosion of collieries, and in many cases as difficult to account for, but having been engaged in examining witnesses upon the recent cases which have occurred, I have collected together some of the most important parts of the evidence, and have also consulted certain scientific authorities as to the effects of steam and water in connection with hot iron, as well as the ordinary apparatus of boilers in respect to the steam and water communications, &c., with a view of inviting discussion, and of bringing forward the practical talent with which the Northern Institute abounds, to endeavor to devise some means of checking this growing evil.

I have endeavored to ascertain how far the danger of explosion is increased by the prevailing custom of having four, five, or six boilers all intercommunicated by the same feed and steam pipes; but practical persons seem to think that there is nothing objectionable in this, inasmuch as each boiler has its own branch pipe, with suitable stop valves.

It is understood in practice, that when one boiler is feeding, all the other feed valves should be shut, because, if two valves are open at the same time, the strength of steam in one boiler may force the water out of it into one or other of its neighbors, and so cause the boiler to become suddenly dangerous for want of water.

The quantity of water in high pressure boilers continues to be ascertained by means of the float or piece of stone suspended or at-attached to a wire led through the boiler top, and poised by means of a balanced-wheel with a weight to denote the rising or falling of the water. This apparatus has been recently improved upon by sundry devices for producing a whistle, or alarum, when the water falls below a certain point.

Amongst the most recent of these applications is Dirck's Patent Anti-explosive Apparatus.

The patentee assumes that boiler explosions, for the most part, originate in over-heating, but not necessarily from a deficiency of water; sometimes from the sticking or over-weighting of the safety valve, and he has, therefore, invented a means for cooling down the water by the introduction of cold water, to flow through coils of pipes immersed in the water, and discharging by a pipe leading outside.

The introduction of the said cold water to be induced by the "*over-heating of the boiler*," and its contents acting upon a fusible alloy, which, when melted, opens a valve or water-cock, connected

with a cistern above, which allows the water to pass into and through the refrigeratory tubing within the water of the boiler, and discharging within sight of the fireman.

"Combinations of tin, lead, and bismuth, in different proportions, melt at known temperatures; thus in parts of 8, 5, and 8, the alloy melts at 212°, while in parts of 2, 3, and 2, the alloy melts at 270°. Then, as we know the temperatures of given pressures, we can accommodate the alloy to melt at very near the required pressure, which I call the "*danger heat*," for 15 lbs. pressure is 251°, 30 lbs. is 270°, and 60 lbs. pressure is 309°. It is not meant to substitute the usual gauges and safety-valves, but to call attention."

Johnston's Improved Self-Acting Alarm is founded upon the assumption that almost all boiler explosions arise from a deficiency of water. He, therefore, proposes to furnish each boiler with the annexed apparatus, so that when the water falls below a certain level, the steam acting upon the instrument produces a whistle. The float consists of a large "*hollow metal ball*," made sufficiently heavy that, in the falling of the water, it opens the orifice and whistles.

A Third Invention for which the author, Mr. Hall, of London, has taken out a patent, is founded upon the following assumption, viz.:—"That explosions are not occasioned by a constant pressure of steam allowed steadily to increase until its tension is greater than the strength of the boiler, but, by permitting the water to become so low as to expose the plates to a high temperature, they surcharge the steam with caloric far exceeding that due to its pressure, and in injecting an additional supply of water into this heated steam, which acts like a blow. It is also known that the water level may be raised even by opening the safety valve, which, instead of tending to safety, may thus become the cause of producing the explosion, which opinion is strengthened by the fact that the greater number of accidents occur immediately after starting the engine." He, therefore, proposes a "*water blow-off valve*," to operate when the surface of the water has fallen to a dangerous extent; the said valve might be made self-acting, either by *a float, or what is preferable* a fusible metal cup, enclosing a bolt head to which the valve is attached at the other end, and retaining it in its seat the valve communicating with the water, and kept in position by a rod terminating with a small head, which is held in the cup by soft fusible metal, and the cup riveted to the crown of the tube or boiler. If the tube or furnace be unduly heated, the rod would be released and the valve permitted to open and discharge the water from the boiler, the pipe connected with this apparatus terminating near the bottom of the boiler, the water to be forced up by pressure of steam—the valve being inverted and kept in its place by a small spiral spring, allowing the float to be at liberty

until the water falls from it when it opens the valve and releases the water. The cup that is riveted into the tube is not lead, but another metal, the quickest conductor of heat, and most fusible that we can find for the purpose, run into it upon the head of the bolt; it is to do away with the lead plug, for we find that the action of the fire on one side and water on the other, so act upon the lead as to oxidize it, so that it almost becomes tin. We have tried several of the lead plugs which have been in some time, and instead of melting at 415° or 420°, they do not melt till nearly 600°, and sometimes as high as 950°, and it is to get over this that we adopt the cup.

"I have had an experiment with the cup standing 2¼ inches above the tube, when it melted the fusible metal whilst the water was still on the tube."

His ideas are still further explained in a subsequent letter of 28th November, 1855, viz.:—

These considerations naturally and inevitably lead to the conclusion that safety is alone to be attained by opening a water-blow-off-valve when the surface has fallen to a perilous extent for the purpose of first discharging the water, which is the more dangerous agent, from the boiler, and then the steam operating, in fact, as a safety-valve placed in a more useful and less objectionable position than the present steam valve, situated on the dome. This valve might be rendered self-acting by a float, or what, perhaps, would be preferable, a fusible metal cup, enclosing a button, by which the valve would be retained in its seat, unless subjected to the temperature at which it was designed to melt. The accompanying sketch illustrating the principle, represents a valve communicating with the water, and kept in position by a rod which serves for its stem, and terminates with a button cemented with fusible metal into a copper cup riveted to the crown of the boiler. If the furnace should be suddenly heated, the button would be relieved, and the valve permitted to open and discharge the water and steam from the boiler. The boiler might be injured, and, perhaps, the flues destroyed by the fire, but it could not be exploded.

A fourth steam and water gauge, the patent of Mr. Sydney Smith, Hyson Green Works, Nottingham, is highly spoken of and extensively used. The following are the remarks by the patentee:—

Steam Indicator.—In construction it is neat, simple, durable, instant in action, and shows every variation of pressure with the most exact and delicate precision, thereby preventing the frequent and disastrous boiler explosions resulting from ignorance as to the actual pressure of steam in the boiler.

For marine boilers the patent steam indicators are well adapted, as they are not affected by the rolling of the vessel or heat of the engine-room, and can be placed in any suitable posi-

tion, either near the boilers, in the Captain's cabin, or alongside the compass.

Magnetic Water Gauge.—In consequence of the frequent bursting of the common glass gauge, and the trouble and expense of renewal, a gauge that is not liable to these casualties is much wanted. The *magnetic gauge* is neat in appearance and simple in construction and action, and is not liable to derangement; it is placed on the top of the boiler, near the front; a copper ball float, which rises or falls with the water, is attached to a magnet behind the dial of the gauge, by means of a brass rod, and causes the movable hand to indicate the height of water with the most exact precision.

Cylinder Water Gauge.—In cases where the upright magnetic water gauge cannot be applied, the *cylinder gauge* is recommended. It is placed in *front* of the boiler, and in principle is similar to the other, except that instead of an upright scale, the magnet attracts a needle round the face of a graduated dial plate, by turning on its axis, worked by a copper ball float.

I will now submit a few extracts, from various authorities, touching the nature of steam, air, and metals, which are more or less involved in the question of the explosion of boilers, viz. :—

The expansion of steam at 212° in comparison with water, is stated at 1800 to 1.

The density of water in proportion to air 832 to 1, and 212 is the boiling point of water.

If common steam be enclosed in a vessel and exposed to a pressure greater than two atmospheres, it will be wholly condensed into water, provided no elevation of the temperature be allowed ("Young's Philosophy"), being the force of cohesion by means of pressure. And air compressed to half its dimensions has its temperature raised about 50° of F., $\frac{1}{180}$th part compressed will raise it a degree.

The elasticity of aeriform fluids is increased about $\frac{1}{480}$th part for every degree of heat; therefore, if the heat be raised to more than 5000°, the force of each grain of water converted into steam will only be increased *tenfold.*

When water is heated up to 212°, the vapor from it resists compression, and makes an effort to expand with a force exceeding that of gunpowder, and this effect is continued with *diminished intensity* as the bulk of the steam increases, till it has arrived at 1800 times the bulk of the water that produced it, when it becomes entirely inert, and has no more tendency to burst a vessel than if it were filled with common air; the pressure of the air and the tendency of the steam to further expansion being an exact balance to each other.

Steam at 212° is just equal to the pressure of the atmosphere, but by increasing the degrees of heat the following results occur :—

	lbs. per Square inch.		Temperature Fahrenheit.		Equal inches of Mercury.
Pressure predominating over the atmosphere acting on the safety valve.	2½	....	220	....	—
	10	....	241	....	20·6
	15	....	252	....	30·9
	20	....	261	....	41·2
	30	....	276	....	61·8
	35	....	283	....	—
	40	....	289	....	82·4
	50	....	300	....	—

So that by a small addition of temperature an expansive power may be given to from 40 to 400 times and upwards its bulk or any other proportion.

A cubic inch of water will produce a cubic foot (1728 inches) of steam.

Latent heat of steam at the common pressure of the atmosphere is found to be 1000°, the sensible or thermometric heat being 212° less 32° (freezing point)=180°, or 1000° added to 180°=1180°.

Quantity of caloric which heats water 1°, heats mercury 3·16, specific caloric of water 1°, mercury 0·31.

Water is 914 times as heavy as air at the surface of the earth. Its greatest density is 42·5, and if heated above or below that point it undergoes expansion in both cases. Thus at 32° and 53° are the same expansion, same at 80° as at 5°—(Dalton).

Expansion of water by heat at

42·5	Greatest Density	1·
102		1·00672
122		1·01116
162		1·02245
202		1·03634
212	Boiling Point	1·04012

The expansion of air is eight times greater than water, and water forty-five times greater than iron, the temperatures of each substance being supposed raised from 32° to 212°. The more bodies are heated the less they weigh.

Hydrogen gas is produced by water in contact with iron heated to ignition, but will not explode at red heat in itself. It is not explosive without a large proportion of oxygen, the most explosive mixture being 2 of hydrogen and 1 of oxygen.

Hydrogen is the lightest of all substances except light and caloric, and when pure it is nearly thirteen times lighter than common air. Under heat the oxygen is absorbed by the iron, leaving the hydrogen inexplosive, *which seems to set at rest a common opinion that explosions sometimes take place from the gas which is formed within the boiler.* Heat is capable of producing a galvanic current, the intensity of which is proportional to that of the producing agent—(Young).

One hundred inches of hydrogen do not weigh three grains, air thirty-one grains. Hydrogen gas is separated by passing steam through a red-hot iron tube.

Hydrogen generally contains half its weight of water.

Iron contains a capacity of ⅛th that of water, for heat;—

lead, $\frac{1}{34}$th; silver, $\frac{1}{12}$th; mercury, $\frac{1}{36}$th. Copper contains nearly the same quantity of heat in a given bulk as water, but lead and glass about one-half only.

Cohesive strength of iron at different temperatures:—

32° to 80°	56·00	This table exhibits a singular discrepancy in the increasing and diminishing ratio which is not accounted for.
570°	66·50	
720°	55·00	
1,050°	32·00	
3,000° fluid query.		

Boiler plate is found to increase in tenacity till it reaches 550, after which it diminishes.

The lowest temperature which gives discoloration to iron (a straw color) is about 430°; and the lowest temperature to effect the repulsion of water has been found to be as low as 350°, whilst the water in the boiler may be only 250°—(Dove).

Rates of Expansion......	Iron and Steel	3	......	Copper	4½
	Brass	5	......	Tin	6
	Lead	7	......	Bismuth	

Melting heat of various metals (Ferguson):—

	Cast iron		Iron red hot in daylight,	12,07°
	Pig iron fuses,	1,500°	Copper melts,	45,37°
	Steel red hot,	1,077°	Hot air for furnace,	612°
540	Lead melts before ignition	594°	Iron when ignited becomes malleable, but requires for its fusion 158° of Wedgewood.	
408	Tin do	442°		
	Brass	3,807°		
	Bismuth melts	476°	Mercury boils at	600°

A writer in the *Gateshead Observer*, Oct. 27, 1855, says—No gas will ignite at red hot iron, it must be a white flame before hydrogen ignites.

Steam may become so pressed as to be equal to iron, and, in consequence, the boiler lifts, and the iron gives way.

One inch of water will expand to 1728 inches of steam. A boiler heated almost to red heat and water admitted, the instant the water touches the red hot iron and made 1728 times its own bulk, becomes more solid than iron. The stronger the boiler the greater must be the explosion.

Gunpowder is 1000 times denser than the atmosphere. If 1000 inches of atmosphere were compressed into one inch, it would be the same strength as an inch of gunpowder. Steam is half the gravity or weight of the atmosphere. If 1728 inches of steam is found from one inch of water, it would be nearly twice the strength of gunpowder. Not one in twenty knows how to find the pressure of the safety-valve.

CONCLUSION.

From the before mentioned facts and extracts I deduce the following safeguards for the prevention of boiler explosions.

1.—It would appear that tube boilers are more liable to accidents from overheating than ordinary boilers, owing to the small quantity of water above the tube, whilst the most intense heating takes place when short of water, and practice shows that little or no advantage is derived from the application of a tube.

2.—Every boiler safety valve should be duplicated by one upon the connecting steam pipe, or an indicator, that upon the steam pipe being equal in area to all the other safety valves.

3.—As very much depends upon the well working of the float, it should either be duplicated or a check apparatus applied upon some other plan.

4.—The bottom of each feed pipe should be furnished with a flap or horse-foot valve, to guard against priming.

5.—The sludge pipe of the boiler should be made to discharge in some place visible to the fireman, as there is reason to believe that the imperfect closing of the said pipe has frequently led to unexpected diminution of the boiler water, and consequent explosion.

6.—It seems highly desirable that the water gauge employed in the locomotive engines should also be applied to ordinary boilers, which gauge exhibits the state of the water within the boiler. It consists of a glass tube with stop-cocks.

7.—I cannot close these remarks without recommending the adoption of a fusible plug of the most esteemed alloy, such plug being placed at the upper part of the tube where such is employed, or in the side of the boiler where most exposed to the flue fire, such plug to be punched out and renewed from time to time to guard against the effects of oxidation.

Art. X.—On Weights Employed in Coinage Accounts—Which Rule the Values of the Precious Metals.

A series of interesting papers relating to the complex weights employed in coinage, read before the American Association for the Advancement of Science, at its recent session in Montreal, by Dr. J. H. Gibbon of the United States Branch Mint, North Carolina, have been condensed into a brief report, for the purpose of elucidating the practices of modern mints, and to render intelligible "the principles" which rule the values of precious metals, as moneys.

First.—The original elements of the old Easterling and Troyes pound weights, each containing 12 ounces, successively used by the early Britons in commerce and at Mints, have been found based upon irregular and indefinite forms or quantities, namely, a certain number of wheat corn grains, never uniform in their weight, were antagonized by a piece of silver called "a penny sterling," constantly differing in purity of metal, alloys, and value.

When advance in science exposed such inefficiency, a yard measure was defined, by ascertaining the length of a pendulum line, vibrating seconds of mean time, *in the latitude of London*, at the level of the sea, and a new pound, specially named "The Troy," deduced from this measure, by a certain cubical weight of distilled water at a stated temperature.

These standards of measures and of weight were deposited in the custody of the Commons House of Parliament, and became the legal standard for the commerce of the English colonies, and eventually for the coinage of the United States.

In the year 1834, the original measures were injured by fire at the burning of the old Parliament House, when the Chancellor of the Exchequer named a commission to consider the steps to be taken for a restoration of the lost standards of measure and of weight. The commissioners have recently declined to recommend the adoption of the former plan for restoration, but consider it desirable to remove the Troy Scale altogether in Great Britain. It is now confessed that the British Parliament has never been able to give unity of measures and weights, even in England, where great confusion at this time prevails in relation both to weights and measures.

Second—Karat grain weights, employed from ancient times by diamond and pearl merchants, goldsmiths and jewellers, in their craft, were at first admitted into the Mint of the United States, to decide the graduated relations of pure metal in any well-melted mass; but proved inconvenient in their structural arithmetic, which was founded upon a natural base of equivocal precision—a dried bean, called "Cuara," awkwardly divided into fourths and eighths. The karat-grains were dropped for a more exact and delicate method of computation, derived from the metrical system of modern France. The *values* of the precious metals depend upon the combined products of the weights for quantity and quality. Differing weights complicate unnecessarily the calculations for coinage.

Third—An accredited but defective avoirdupois *ounce* of silver—the dollar piece of Spain—was early introduced into the Mint of the United States as an *arbitrary unit*, to proportion the moneys of account, instead of the eccentric arrangement of pounds, shillings, pence, and farthings, inherited by British colonies from the mother country.

Avoirdupois weights have been traced to the early emigrations of maritime Phœnicians. They seem to have formed a money standard for neighboring nations—the Assyrians, Egyptians and Hebrews—according to the oldest records. These peculiar weights *may* have been based upon some processes of terrestrial admeasurement, similar to those which characterize the Modern Decimal System of France, for such evidence exists in the *relative* values which the *ounces* bear between two precious

metals, sixteen ounces of standard silver being held rather regularly, equal to one ounce of standard gold in ancient and in modern money, by the actions of an extended commerce.

The ounces of the avoirdupois pound being individually *lighter* than the ounces of the Troy weight, or Easterling, have gradually gained a preference in trade, among prominent commercial nations.

By recommendation of the Royal Society, an act of Parliament, *after deducting eight grains* from the avoirdupois pound, *declared* that weight to be the imperial standard or Great Britain and her dependencies.

By a like process of reduction, the modern *ounce* of silver, or dollar piece, has been repeatedly contracted in the number of its grains from the primitive weight carried into Spain by the Tyrians, who settled Cadiz 3056 years ago, according to accredited statements.

The Hebrews indicate the same standard as their "current money" of account, the half ounce avoirdupois of silver or the shekel" weight.

Fourth—Toward the close of the last century, cautious and faithful admeasurements were pursued by the mathematicians of France, aided by other physicists, to define the extent of certain degrees of the earth's surface from the level of the sea, near Dunkirk in France, to the same level opposite Barcelona, in Spain.

By such measure of an arc of the meridian, the distance from the equator to the pole of the earth was carefully calculated. Thence was decided the entire circumference of the globe we inhabit.

These geometrical computations were *checked* by careful experiment upon the length of a pendulum, vibrating seconds, at the 45th degree of latitude, to test *the time* or the diurnal rotation of the earth upon its own axis, and thus to *prove* the other estimate and calculations. From a certain graduated portion of the meridional length from the Equator to the Pole, namely, the ten-millionth part, a distinct "meter," or standard linear measure was obtained, from which rule a cubical weight of pure water, near the freezing point or that of greatest density, gave a standard weight, or quantity, for all measures of capacity.

An exact coin, "the franc," was deduced from the same unitary measure, multiplied or divided decimally, for money quantities both in commerce and at mint.

The French scale for decimal calculation was presented to the essay Departments of the Mint of the United States in 1835, where it has received the general approbation of the officers who employ it, for simplicity, facility, and completeness.

The admission of the entire system of the metrology of France into *every one* of the departments of the mints, will disem-

barrass them at once from the annoyance of *perverted* Troy and Avoirdupois weights, and enable them immediately to assimilate the values of the respective coins exactly with those of France and oth e nations, who have already, or may hereafter adopt that thorough decimal system.

No change need be made in the fineness nor titles of our coin, nor any in our moneys of account, according to the experience of those nations on the continent of Europe who have accepted this economy in their mints. A slight alteration *in weight alone*, fractions of a single grain, will establish the new silver coinage almost imperceptibly among us. Indeed, the gradual reductions hitherto made by law in the weight of the silver coins of the United States below the denomination of one dollar, have produced such *close approximation* to the French moneys, that two half dollars of our present standard, weigh *one grain less* than a silver five-franc piece of France.

A perfect conformity in the gold coinage can be readily arranged by consultation at the national mints of the two countries, and a slight action of the respective Governments.

ART. XI.—ON THE MODE OF FORMATION OF CANNEL COAL. By J. S. NEWBERRY.*

CANNEL coals as a class, when compared with other bituminous coals, are characterized by greater homogeneity of physical structure and of chemical composition, have a more laminated fracture, —in pure specimens conchoidal across the planes of stratification, —contain more earthy and more volatile matter,—and of course less fixed carbon,—and envolve gases having a higher illuminating power. The fossils which they contain are either aquatic or exhibit marks of the action of water. No satisfactory explanation of these differences having been given by writers on the subject, I was led to seek such explanation in the phenomena presented by the numerous strata of cannel coal which are found in the Ohio portion of the Alleghany coal-field.

A series of observations on these beds of cannel, on the changes which they exhibit in going from one point of outcrop to another, their physical and chemical characters, their structure as indicative of their mode of deposition, their fossils and geological associations, has resulted in giving me the conviction that the peculiarities of cannel coals are due, principally, *to the chemical and mechanical influence of water in which they were deposited;*

* Read at the Albany meeting, Amer. Association.

secondarily and locally, *to the presence of a portion of animal matter.*

The facts which have led me to these conclusions are briefly these:—

1st. Cannel coals always exhibit a tendency to assume the foliated structure of slates and shales,—a structure which they must have derived from aqueous deposition. They are frequently found shading into bituminous shale, into which they are converted, simply by accessions of earthy matter. Bituminous shale and cannel coal may, therefore, be considered as the same substance in different degrees of purity; that is, carbonaceous paste, deposited from aqueous suspension with different admixtures of earthy matter.

The carbonaceous matter in bituminous shale, as in cannel, exhibits a preponderance of volatile matter over fixed carbon, and the gases furnished by it contain a larger proportion of the more volatile hydro-carbons, and possess a higher illuminating power than those derived from ordinary bituminous coal.

2nd. The chemical composition of cannel coal—so rich in volatile ingredients—and its homogeneity, are such as would naturally follow the decomposition of vegetable matter while constantly submerged.

Plants when deprived of their vegetative life, and exposed to the action of the air, are slowly decomposed by the process of decay; a process which, unattended by the sensible phenomena, heat and light, is however really a combustion, and consists in the union of oxygen with their hydrogen to form water, with their carbon to form carbonic acid, and of their carbon and hydrogen to form carburetted hydrogen, &c.

When vegetable matter is covered with wet earth or clay, these changes are both modified and retarded, and an intermediate state, that of bituminization, is assumed by a portion of the organic matter.

Under water the changes terminating in decay go on still more slowly, and a larger portion of the vegetable tissue becomes bituminized.

The process of bituminization in such circumstances consists in the oxidation of a small portion of carbon—which escapes as carbonic acid,—of hydrogen to form water, the union of carbon and hydrogen to form carburetted hydrogen and other hydrocarbons, and the combination and removal of a portion of the alkaline carbonates, of nitrogen, &c., all of which go to make up the loss, which is relatively small. The residuary hydrogen and oxygen unite with a portion of the carbon to form bitumen, which closely resembles, physicially and chemically, the resins produced by the vital functions of many plants. This bitumen unites mechanically with the uncombined or fixed carbon, the remaining alkalies and inorganic matter, to form coal.

It is evident that the more ready the access of oxygen to the carbonaceous matter during the process of bituminization, the larger proportion of the products of complete combustion will be mingled with those of this process, and the more perfectly the oxygen is excluded, the larger proportion of the more volatile (i. e. more oxydable) constituents of the wood will be retained.

Of the conservative influence of water on vegetable matter we have evidence, not only in the great durability of wood when constantly submerged, but in coal itself.

In all coal strata except where the process of volatilization is complete, as plumbago and perfectly gasless anthracites, the work of decomposition is constantly going on. To this, as to ordinary combustion, water is an extinguisher.

Coal mines are commonly opened in this country by penetrating the coal on some hill-side where it is not covered by water. In these circumstances a progressive change, both chemical and physical, is noticeable in the coal from its outcrop to the point where atmospheric influences cease to act. Near the surface it is friable, lustreless, and nearly destitute of gas, having much the appearance and character of decayed wood. As it is more deeply penetrated it becomes harder and more brilliant, and contains more volatile matter, till under water or a sufficient cover of incumbent rock, it is protected from the action of oxygen.

On the contrary, whenever the outcrop of a coal stratum is constantly covered with water, even though it have no other covering, it will be found hard and bright, and containing nearly its maximum quantity of volatile ingredients.

3d. The higher illuminating power of the gases of cannel is a natural consequence of the preservation of the more volatile constituents of wood, by its continued submersion in a hydrogenous liquid.

It is also probable that the illuminating power of cannel gas is often somewhat increased by the animal matter which it contains. I have found remains of fishes in slaty cannel, surrounded by bitumen having in a high degree the characteristics of the bitumen of cannel.

That a more resinous vegetation has given cannel this character is, I think, not probable. I have often found unchanged resins in common bituminous coal, but never in cannel.

4th. The greater relative proportion of earthy matter in cannels would be a necessary result of the submersion of the vegetable matter in a fluid having a greater specific gravity than air, and, of course, greater power for the suspension and transportation of sediment. In the few instances known where the cannel is of equal purity with bituminous coal, we may, I think, discover evidences that the vegetable matter has been deposited in confined bodies of quiet water, entirely without currents, or, at least, receiving little or no surface drainage.

5th. The fossils contained in cannel coal are among the most significant indications of its aquatic origin.

Fishes are found in cannel in abundance, scales, teeth, spines, coprolites, and entire individuals being, in some localities, so profusely scattered through its substance as to prove conclusively that they must have lived and died in great numbers in waters, at the bottom of which comminuted vegetable matter was accumulating as a carbonaceous paste, with which their remains have mingled, and the whole, consolidated, has become a stratum of cannel.

I have before me as I write, pieces of beautiful cannel from England, in which are impacted teeth of *Megalichthys*, scales of *Paleoniscus*, and many other forms of aquatic life. And in Ohio I have found fishes in large numbers in a thin stratum of cannel underlaying a thick seam of bituminous coal; which last contains none.

Shells too are not unfrequently found imbedded in the middle of a stratum of cannel.

The vegetable remains which I have observed in cannel are *Stigmariae*,—roots and rootlets of trees which grew in the coal-marshes,—generally occurring in detached fragments—shapeless portions of the trunks of *Lepidodendra* with their markings nearly obliterated, *Lepidostrobi* reduced to their woody skeletons, fern fronds of which nothing but rachis and veins remain, all evidently macerated till only their most resistant tissues are left.

Strata of ordinary bituminous coal usually consist of thin layers of brilliant bitumen alternating with others of bituminous shale or cannel. This arrangement I consider due to the variable quantity of water saturating and overflowing the coal marshes: the cannel layers having been deposited during the prevalence of high water.

Art. XII.—MINERAL RESOURCES OF SOUTH CAROLINA.*

(Continued from page 121, Vol. IX.)

In Germany especially, the production of brown coal is extensive and steadily increasing. Prussia in 1855, produced 2,126,113 tons, and in Nassau a prominent portion of the inhabitants make their living by the brown coal mines of the Westerwaldt. From this region, notwithstanding obstructions requiring

* Report on the survey of South Carolina, being the first annual report to the General Assembly of South Carolina, embracing the progress of the survey during the year 1856, by Oscar M. Lieber, Mineralogical, Geological and Agricultural surveyor of South Carolina.—*Columbia, S. C.*

several expensive tunnels, a railroad is at present constructing for the sole purpose of transporting this useful fuel to the Rhein. Some years ago, when on a visit to Prussian Poland, I found an excitement prevailing, in consequence of the recent opening of brown coal deposits in the neighborhood of Ladowiez, similar to that attending some of our most important gold discoveries.

Taylor, in his work on the "Statistics of Coal", p. 320, gives a list of all the known workable deposits, which it is, however, needless to copy here.

The heat produced by lignite is about a third greater than that of wood. It burns slowly, and is on that account much liked as a household fuel; the heat emitted being very equal and regular. Its slow burning, however, and the impossibility of increasing or decreasing the temperature rapidly, renders it inapplicable to smelting purposes in its natural state. The cokes are used in the duchy of Nassau, in some processes of the manufacture of iron, and the gas, made from it, is employed in refining iron at the famous works at Mægdesprung and at a gas-puddling furnace at Ilsenburg. This fact, collaterally proves its adaptability for the manufacture of illuminating gas. For steamboats it has been repeatedly used with advantage. Thus the oolitic lignite of the island Veglia, is excavated for the use of the Trieste steamboat.* In Texas, Trinity county contains an abundance of brown coal, which probably already supplies the Galveston steamers. Its utility and especial fitness for this purpose has at least long ago been shown.†

When we take into consideration that our State contains no other coal, and reflect upon the great service of which the opening of a good brown coal mine would be, close to a navigable river, the Great Pedee, there is certainly ample inducement offered for the continuation of such explorations by private capital, which neither the character nor the limited means of the State survey would permit to be more than commenced. I allude, of course, to exploring shafts and to borings. In these, it should be recollected that a succession of beds very often exists, so that it would be injudicious to cease boring or sinking after the first bed has been struck. Far less noticeable surface indications have led to the indication of valuable deposits; and it is, therefore not extravagantly sanguine to express the hope, that the matter will not be allowed to rest as it is.

It may not be useless to state that the great abundance of iron pyrites in the clays of the brown coal, would be well adapted to the manufacture of alum.

* History and Description of Fossil Fuels, by the author of "Manufactures in metal." London, 1841, p. 477.

† Silliman's Journal of 1837, page 216 and 217—a method for using brown coal for steam engines was invented by Dr. Kuphal.

CLAYS.

To enumerate all the localities, where clays suitable for pottery are found, would be impossible. Some which are, however, not undeserving of attention occur on King's Mountain, on Mr. Well's land. One of them especially is particularly well adapted to the manufacture of fire-proof crucibles, while a clay, which strongly resembles the famous one at Stourbridge—from which the crucibles used in England in making cast steel are produced —is found in nodules of great purity in the bituminous clay beds of Whortleberry branch.

The yellow clay of the melaphyre and porphyries, though tenacious from the moisture it contains, does not seem to be sufficiently plastic for the potter's use. Excellent bricks are, however, produced from it.

Two kinds of clay are used by the Catawba Indians for culinary vessels and for pipes. That employed for the former, is yellow and contains no organic matter, while that of which the pipes are made, is rendered gray from the quantity of comminuted organic matter, and is a deposit underlying the alluvial soil along the Catawba river. As these Indians are so rapidly dying out, that they will scarcely last another generation, it may be worth while to mention their process of working the clay, under the impression that it may interest some readers. The Indian pottery is the only visible remnant of the national peculiarities of these poor people, their present state showing a great degeneracy even, from their original savage one.

The manufacture of pots and other coarser articles contains little of particular interest, but that of the pipes, in which they excel, is more interesting. These are rendered exceedingly light and porous by the burning away of the minute particles of carbon. The clay intended for them is first thoroughly kneaded, and then roughly moulded by hand into the shape intended to give it. The lump is then left till it has dried sufficiently to receive a more perfect shape with a knife and a smooth stone used for polishing. After this the two holes are made with a stick, and the unburnt, but otherwise finished pipe is left to dry. When all moisture has been thoroughly removed, the pipe is warmed by the fire, and then covered with oak bark, a vessel of some sort being placed over the whole. A small fire is then built over all, and sustained untill the inflammable gas has ceased to escape from beneath the inverted vessel, and the oak bark is therefore completely burnt. Owing to a complete saturation by carbon, the pipe is then perfectly black. It is in this manner, only, that they color them so thoroughly.

Another clay is derived from the decomposition of the felspar of the quartz porphyry dikes. This is porcelain clay of an exceedingly fine quality, and is found chiefly in Chester, near the

Court House, and also at Dr. J. Mobley's. That near Chesterville has already been employed in the manufacture of some of the finest kind of porcelain for artificial teeth. It occurs in great abundance, and might be profitably used on a large scale. Felspathic beds, yielding a fine kaolin, also occur in north-western York.

BUILDING STONES.

Of these there are a number of peculiar beauty belonging to the granites, gneisses, porphyries and the new red sandstone. As their qualities have, however, been mentioned in speaking of the rocks themselves, a repetition would be caused if they were enlarged upon here.

LIMESTONE.

The same reasons, which induced the description of the specular schist in this chapter, occasions the mention of the limestone also, while similar objections might also be urged against its introduction.

The limestone is found in north-western York, west of King's Mountain, overlying the itacolumite. Two prominent beds, or rather long extending outcrops, occur, owing to folds of the bed, as seen in the ideal section on plate V. Another outcrop, on the south-western termination of Whitaker's mountain, Mr. Black has enabled me to point out. This is only twelve feet in width, though probably widening below as the section shows. The other outcrops, which have been quarried at various places for a long time, average both about half a mile across, where they are most extensive. The two limestone, outcrops are separated sometimes by itacolumite; sometimes by the talcose stratum only, which immediately underlies the limestone, and, near Mr. Black's house, by clayslate, into which the talcose schist seems to pass locally. They unite into one before striking the river.

Beds of a fawn-colored talcose and argillaceous schist occur as intercalations. These are termed "fox rock," by those who quarry the limestone. Their presence in the kilns is, of course, detrimental to the quality of the lime. The appearance of the latter is also somewhat affected by the occasional presence of pyrites. Of these iron pyrites is the most common, but, at an old quarry of the King's Mountain Iron Manufacturing Company, I also found copper pyrites distributed in minute streaks in the limestone.

Art. XIII.—COAL FIELDS OF THE EAST INDIAN ARCHIPELAGO.*

Labuan, Bruni, and Sarawak.—Little more than ten years ago, the only known coal bed in the Indian Archipelago was that of Pulo Chermin, at the entrance of the Borneo River. Subsequent researches, however, show that the mineral is scattered pretty plentifully over the area included in the great bank of soundings which extends to the southeast, from the Malayan and Indo-Chinese Peninsulas to the Bonirati Group, south of Celebes. But in countries where manufacturing industry has made little progress, coal is only required in large quantities for the use of steam vessels, and the beds become valuable or otherwise in proportion to the facilities offered for supplying depots. As freight forms the most important item in the cost, those coal fields which happen to be in the immediate route of steamers, and admit of their receiving it direct from the pit's mouth, are necessarily the most important, and it was for this reason that we gave precedence in our series to that of Mew Bay, in the Strait of Sunda.

Of the coal fields of the northwest coast of Borneo, those of Labuan and Bruni, where the seams are of a thickness calculated to astonish the home miners, are capable of supplying steam lines in the neighboring seas for many years to come, and although Labuan lies out of the direct track between Singapore and Hongkong, it is more than probable that when the increase of competition causes the new lines between India and China to be less profitable than at present, it will be found necessary for the sake of economy, that the steamers should call at Labuan, either going or returning, for a supply of coal to last the entire round. Nor will much time be lost by so doing, as smoother water is experienced during both monsoons on the coast of Borneo than on the other side of the China Sea, a point of importance to auxiliary screw steamers when making the passage against the monsoon. But the spirited proprietors of the Labuan mines do not seem disposed to await the course of events, and the steam-collier they have sent out to run from Labuan to this port and Hongkong, (a vessel of 1,000 tons burthen, and peculiarly adapted for the service,) is likely soon to settle the question as to whether the produce of the mines of Borneo can compete with British coal at the Eastern depots. Sail-vessels are not well adapted for service as colliers in these seas, where the periodical winds blow for six months together in opposite directions, except when it happens that the mines and market are so situated with regard to each other that the passage can be made both ways with a fair wind, as is the case with Sourabaya and the coal fields of South Borneo.

The last overland mail brought intelligence that a company had been organized for working a coal field in Sir James Brooke's

* From the Singapore Free Press.

territory at Sarawak. Very little seems to be known about it except by the parties interested, but there can be little doubt of its becoming a valuable acquisition to steamers frequenting this settlement, as the distance across is rather under 500 miles. The Sarawak mine, however, from its inland situation, will not be so well adapted as a coaling station for steamers as that of Labuan, which lies on the shore of a navigable strait, so that passing vessels can load their coal from the pit's mouth without diverging from their course.

Banjar-Massin and Koti.—The island of Borneo appears to be one great coal field, for every large river intersects a coal-bed, and it seems only necessary to seek and mineral is found. Thus every settlement, indeed every spot frequented by Europeans, has its mines more or less convenient. Labuan, Bruni, Bintulu, and Sarawak, on the north coast, the banks of the Kapuas on the west coast, Banjar-Massin and the banks of the Great Dyak River on the south coast, and Pulo Laut, Pagattan and Koti on the east coast, each has its coal field, although those only which we notice are worked at present for other than local purposes. The mines of Banjar-Massin, which lie about 70 miles above the town, on the banks of the Batu-Api River, are the most important of those at present worked within the Dutch-Indian territories, not on account of the superiority of the coal measures, for the main seam is only 9 feet through, but owing to the favorable position of Banjar-Massin for communication with Sourabaya, the chief naval arsenal of the Dutch in these seas, and where the consumption of coals is probably greater than in any port of India excepting Calcutta. In addition to the supplies required for war-steamers, and for the boats employed in keeping up the communication with Celebes and the Moluccas, steam engines are pretty constantly employed in pumping out the dry-dock and in working the machinery of the great steam factory, where the engines of government, and of the sugar *fabriques* in the eastern part of Java are made and repaired. The Banjar-Massin coal is well adapted for steam purposes, as it burns freely and does not cake or 'clinker,' but for the same reason it is not so well adapted for the forge as English or Australian Newcastle coal. The cost of the mineral, delivered at the depot in Banjar-Massin is 2 guilders (3s. 4d) per ton, and the freight across to Sourabay varies from 5 to 8 guilders more. It is usually exported in large blocks of an oblong form, the small coal being either thrown aside or kept for home use. Large prahns and square-rigged vessels belonging to Arab and native traders of Sourabaya and Grisse are chiefly employed in the transport, and as they would otherwise have to lie idle during several months of the year, the freight is sometimes very low. During the southeast monsoon, the voyage across both ways, rarely lasts more than two or three days.

The mines of Koti lie on the banks of the river of that name,

about eighty miles from the mouth. They are worked by Mr. King, an English trader who has resided there for some years past, but the demand is not very great, owing to their inconvenient position with regard to a market. The coal is of the same highly bituminous character with that of Labuan and Banjar-Massin. Whenever steam comes to be generally employed in these seas for the transport of merchandise, the Koti mines will be found useful in supplying coal depots in the Strait of Macassar. The distance across to Paré-Paré on the opposite coast of Celebes is about 100 miles.

Seams of coal have been found at Reteh and Palembang, on the east coast of Sumatra; near Macassar, on the island of Celebes; at Bawean, an island in the Java Sea; and at Bachian, in the Moluccas: but those we have already enumerated are the only beds that admit of being worked with convenience and profit. It will be found on examination that all these are included within the submerged plateau which extends from the south-eastern part of Asia nearly two-thirds of the distance across to the nearest point of the continent of Australia, and further examination will show that they occur only on those parts of the plateau which have been subjected to violent upheaval since the formation of the sedimentary rocks, a process which has tilted and broken through the strata, exposing sections to the view of any traveller who may be passing over the country. It is thus that every known coal field in this part of the world has been discovered, and we believe that in every instance the discoverers have been the natives of the country, to whom, indeed, the existence of some of the most important beds seems to have been known through many generations. Now there is no peculiarity in the geological structure of the regions where coal is known to exist, which renders them more favorably constituted for the formation of the mineral than other parts of the plateau, say the island of Singapore itself; indeed there is not only a possibility but a reasonable probability that it exists under our very feet. Certainly nature has not been so considerate as to display her workings to the public gaze, as is the case in the regions bounding us on either side; but does not science furnish us with the means of ascertaining the character of the earth's crust to any required depth, with small expense and labor, by means of boring? No doubt, were the result successful, an outcry would be raised against the government authorities for having heretofore neglected so simple and inexpensive a means of ascertaining the *internal* resources of the island, so that no movement can reasonably be expected in that quarter; but the authorities of the Steam Navigation Company would be fully justified in devoting a small portion of their immense revenue to carrying out a series of experiments, which, if successful, would be the means of curtailing their expenditure to the extent of some tens

of thousands per annum. Probably no more favorable spot could be found for commencing operations than the immediate neighborhood of their depot at New Harbor, where the surface indications, shale and sandstone, are such as are always associated with the coal beds, although their presence does not imply the actual existence of the more valuable mineral. That such measures may be carried out even by private enterprise, will be seen by an extract we append, which gives the result of a similar experiment at Ipswich, a small but rising town of the Moreton Bay district of New South Wales, by two gentlemen, who, we are informed, follow the occupation of millers and storekeepers. The Moreton Bay District was not occupied until some years after this settlement had been formed, and the town of Ipswich is scarcely ten years of age. This successful experiment nearly doubled the value of the town allotments in the course of a few hours after the result became known:

"We have great pleasure in calling the attention to the recent discovery of a valuable seam of coal on the property of Messrs. Walter Gray & Co., situated on the north Bank of the Bremer, about one mile from the town. This desirable work was commenced some months ago, and notwithstanding great difficulties supervened, such as boring through masses of hard rock, those difficulties have been surmounted, and the discovery of a seam of coal nine feet in thickness has rewarded the exertions of the enterprising proprietors. The shalft was sunk to the depth of 100 ft. before the miners came to the coal, and from the nature of the superincumbent strata it is expected that the mine can be worked both with profit to the owners and security to the people employed. A sample of the coal has been forwarded to town, and has been submitted to the inspection of competent judges, who have pronounced it to be quite equal, if not superior, in quality to any hitherto discovered. It appears to be that description which is known as *caking* coal, and we understand it is very pure, and leaves after combustion a very small percentage of ash. The sample before us seems to be highly bituminous, and well adapted for the purpose of producing steam which sets machinery in motion."—*North Australian.*

COMMERCIAL ASPECT OF THE MINING INTEREST.

New York, Sept. 25th, 1857.

Since our last report a cloud of the blackest kind has come over all kinds of securities. The market has been dull for every kind, and prices are merely nominal. No sales have been made for many days at the New Stock or Mining Board. The state of the money market has been more stringent than at any time for the last five or ten years. It has been at last found impossible to carry floating debts by any company.—The rates of discount for the best kind of mercantile paper have been as high as 2 per cent per month; and 3 to even 4 per cent. for many kinds. Railroad paper has been found impossible to sell. It has been found worse at Philadelphia than here. The Delaware, Lackawanna & Western Railroad Company, a coal as well as railroad company, has been obliged to suspend payments for a time; and its stock has fallen from 50 to 11 per cent. Being a foreign corporation, it was found necessary to protect its property to assign it: and Messrs. W. E. Warren, Treasurer, R. R. Graves, a director, and John I. Blair, President of the Warren Railroad Co. were appointed the three assignees. The stockholders met on Wednesday the 23d Sept. to consider the matter, when a committee was appointed, consisting of James Brown, Simeon B. Chittenden, M. K. Jessup, C. R. Robert, W. M. Vermilye and W. H. Smith, to confer with the directors on the means of raising the sum of $1,400,000 to pay off the floating debt. The means will doubtless be obtained. The directors are the largest stockholders; and the stockholders are all rich capitalists—the richest body of stockholders of any corporation. But it shows forcibly the distress of the times that such a company should be allowed to submit to an assignment. The Reading Railroad Company has suffered in its stock from general depreciation and a large floating debt. Its stock fell as low as 32. The stock of the Cumberland Coal Company has fallen to 6 per cent. Its $5,000,000 valuation of capital stock is thus actually worth less than $500,000. There is no prospect of this stock ever being worth 100 per cent; and the company had better therefore reduce its par value of 100, to one quarter of the sum, or an amount more near its market value, on which it would then be able to pay regular and reasonable dividends.—On so large an amount of 5,000,000, it requires a very large sum to pay a small pro rata dividend, and therefore its large fictitious capital prevents dividends being made. The stock of the Pennsylvania Coal Company has rallied a little, having risen from 60 to 67½; but the far distant prospect of any resumption of dividends prevents any great appreciation. We observe no other mining stocks quoted at the old board of brokers; and the new board has suspended operations till the money pressure relaxes.

Parties are now in Tennessee inspecting the copper mines there, and are organizing the Consolidated Company to which we alluded last month. The negotiations for their sale in England, which have been carried on for so long a time, have fallen through. At the Hiwassee Mine, the captain was prosecuting his explorations throughout the mine, and had in all parts been successful in finding ores of a rich quality.

The furnaces in operation were turning out regulus varying 50 a 60 per cent. The Trevorton Coal Company of which Mr. Beebe, the bullion broker, was president, owes all its means to that gentleman, who has now failed. The want of confidence evinced by the capitalists of New York, maintains the rates of discount at such high figures as diverts all capital from present investments. Money is only raised by submitting to such enormous rates for the purpose of liquidation. Business is much contracted for the season; and this, with the natural process of liquidation, will in a few months liberate much capital from employment and lead to a reaccumulation of money in market. The houses in good condition keep more money on hand than they want. Numerous failures have occurred in New York and Philadelphia in the month of September; some of which were very large houses. The Independent's list of failures for the month enumerated nearly 300 failures, a frightful list. The present month (October) is a very heavy one for payments, and much anxiety is felt for many more houses having payments to make. In Philadelphia the heaviest fall payments are in September. In New York a month later, and in Boston in November. The daily payments as exhibited through the clearing house have fallen off enormously. The bank contraction in August was very heavy, but it was continued in September, though then there was an increase of deposits of specie.—Since the 8th August, the banks contracted over fourteen millions of dollars, an amount of contraction sufficient to ruin any community not having the strong backbone, and solid basis of wealth that exists in New York. New York State and its merchants have great pluck with regard to their credit, preferring to make sacrifices rather than lose it, if possible. The country is wealthy. The products of the mines and the field are large and constantly increasing; and when this year's produce is fairly set in motion, the circulation will revivify the whole community. Freights are reviving from a revival of shipments of grain. Foreign exchange is falling from the same cause. Gold comes in freely and more is expected. The banks have to-day about $14,000,000 in their vaults, and sub-treasury in New York $10,000,000. Prices of cotton are well maintained, and all that is produced is hardly sufficient for the demand. The production of goods at home has been checked; having of late proceeded too fast; and the over-supply occasioning prices to fall below cost.

When manufacturers get agoing, they seldom stop till the markets they supply are glutted by over-supplies, when a check is applied, but with an accompanying serious loss that ought to have been foreseen and avoided. The country is well to do in the main; but the ignorance constantly shown in adapting means to ends involves individuals in trouble, and sometimes in ruin.

We have received a statement regarding the "Real del Monte" Silver Mining Company of Mexico, and, from the source from which it comes, we presume it to be eminently reliable; it will be found interesting, both financially and mechanically. We give it on the following page:

NOTES REGARDING THE "REAL DEL MONTE" SILVER MINING COMPANY IN MEXICO.

Statement showing the mean cost of reducing a monton, 3000 lbs., of ore at the "Real del Monte Company's" Reduction establishments of Sanchez, Velasco, San Miguel, and Regla, during the year 1854, and showing comparative economy of the different processes employed.

	By Barrel amalgamation at			By Patio amalgamation	By smelting
	Sanchez.	Velasco.	San Miguel.	at Regla.	at Regla.
Stamping, mostly for labor	$ .64	$ .59	$ .60	$ 26	$ .30
Wear of Stamp heads (*88c)	.24	.25	* .88	.28	.28
Grinding in arrasters, mostly labor	.78		.8	.83	
Drying and Sifting, mostly labor	1.30	1.20	1·02		
Calcination, mostly labor	2.15	1.76	1.57		
Amalgamation in Barrels and Patio, labor	1.41	1.04	.88	3.98	
Smelting in Furnaces, mostly labor					17.80
Wear of barrels	.35	.30	.21		
Distilling amalgam and casting silver into Bais.	.8	.10	.7	.5	.4
Repair of machinery, furnaces, &c.	.33	.60	.50	.48	8.90
Sundry costs	.55	.30	.40	.40	3.40
Salaries and expenses of general management, assaying, &c.	1.31	1.14	1.03	1.09	6.80
Total	9.14	7.48	7.24	7.37	32.52
Fuel (wood)	3.79	3.81	4.27		1.00
Fuel (charcoal)	.31	.30	.27	.20	34.90
Salt	6,70	5.37	6.60	3.64	
Sulphate of copper				2.13	
Litharge					21.50
Tallow and oil for machinery	.33	.37	.29	.10	
Total	20.27	16.83	18.67	13.44	89.92
Quicksilver	2.15	2.39	1.58	4.32	
Steam power, mostly fuel	1.91	4.23			
Annimal power, mostly forage	2.14				
Total cost of reducing a monton or 3000 lbs. of ore	26.47	23.45	20.25	17.76	89.92
Ores reduced in 1854, in cargas of 300 lbs.	48.310	53.895	49.184	37.982	238.6
Mean produce of silver per monton of 3000 lbs.	92.88	94.80	62.40	65.92	518.40
Ounces of quicksilver lost per $ of silver produced	.59	.62	.66	1.59	1.50

Yield of ore from different mines belonging to the company.

The ore from the Rosario Mine gives,	$108 per monton of 3000 lbs.
San Patricio gives	73.60 " "
Poor and refractory ores from the St. Brigida and Santa Inez gives	58

These latter, though not bearing a very large profit, have materially assisted the Company's finances, and now that the mines of "Jacal" and "Rosario" are supplying the Barrel works with a richer class of ores, the extraction of the above from the Santa Brigida and Santa Inez, is being gradually reduced and left as a reserve.

Average yield of all ores reduced to 1854, $78 per monton. Total amount reduced by the Company, 1849 to 1854, inclusive, 684,845 cargas, or 97,835 tons, producing $5,858.330; or 5,352,600 ounces of silver, bring 54½ oz. per ton.

The Patio process lasts 30 to 50 days.

By the Barrel process, the ore, after being ground and sifted, is roasted in furnaces with 5 per cent. of salt, by which the silver is separated from its original state of sulphurets, and converted into chlorides of silver.

The ore thus prepared is next made into a stiff paste by revolving in large barrels (containing each 2500 lbs. of ore) with water, and then, after the addition of iron and quicksilver, the first ingredient by superior affinity again separates the chlorine from the silver, which is collected by the quicksilver

and converted into an amalgam, when, by the subsequent process of washing, the amalgam is first separated from the refuse mud, and then by distillation the silver from the quicksilver.

The process is performed in 24 hours, and destroys less quicksilver than the Patio, but requires more power and machinery for revolving the barrels, uses nearly double the quantity of salt, and consumes much fuel for roasting the ores.

Thirty stamp heads, 50 to 80 strokes per minute, can grind of the quartz ores 100 tons per week to an exceedingly fine sand. To effect the annual grinding of 35,000 tons, not less than 60 tons of cast iron are worn away.

Silver left unextracted by the several processes, smelting 6 per cent.; Patio amalgamation, 15 per cent.

At Velasco by barrel process 16½ per cent., and on the average of the three haciendas employed on this process (barrel), 19 to 20 per cent.

The supply of salt is from San Luis (land carriage 300 miles, $42 per ton) and from Tampico and Tuspan, by shipping from Campeachy; by either route it costs $84 per ton. 1,700 tons are required to reduce 35,000 tons of ore.

Consumption of wood in 1854, 60,000 tons, or 450,000 cargas, which costs at least $150,000 per annum.

Total produce of the Real del Monte Company's mines in 1854, $1,811,882.

These mines are now producing over 3,000,000 per annum, at a profit of nearly one half to the stockholders.

NEW YORK COAL MARKET, Sept. 26, 1857.

The general depression in business affects this branch of trade the same as others, and is perhaps more seriously felt because so large a portion of it is labor; this is cash, and consequently the pressure in the money market has caused the suspension of some operators. Prices are without change to note, with less doing by the cargo. We quote sales by the cargo for Chestnut and Prepared $3 65 to $4 75. By retail from boat $4 10 to $5 25. Prime coal from yard $4 50 to $5 50 for small and large size. In foreign little has transpired; the supply is not very large. The sales are a cargo of Haleburton's Orrel at $9 00, and of House Cannel at $11 00, 4 months.

The following is a statement of the anthracite coal tonnage from the Lehigh and Schuylkill regions for the last week and the season, giving also a comparison with the tonnage of the corresponding period last year:

This is the most unfavorable report we have presented this season. The coal trade has never been so depressed since it began to assume any importance.

The loss for the last two weeks is upwards of 53,000 tons, and we should not be surprised if the loss from the above regions would reach from 40 to 45,000 tons the ensuing week. The increase so far over last year's shipments amounts to only about 75,000 tons. Two weeks ago it was 126,000 tons.

	Lehigh.		*Schuylkill.*	
1857.	Week.	Season.	Week.	Season.
Canal	30,089	658,753	28,176	903,161
Railroad	9,281	336,802	25,327	1,423,520
Total	39,370	995,555	53,503	2,326,681
Same time last Year.				
1856.	Week.	Season.	Week.	Season.
Canal	34,716	852,037	33,426	810,387
Railroad	6,853	105,508	55,888	1,652,169
Total	41,569	957,545	89,314	2,462,656

Recapitulation of the season.

	1856.	1857.		
Lehigh Canal	852,037	658,753	Dec.	193,284
" Railroad	105,508	336,802	Inc.	231,294
Schuylkill Canal	810,387	903,161	Inc.	92,774
" Railroad	1,652,169	1,423,520	Dec.	228,649
Total	3,420,101	3,322,236	Dec.	97,865

BOSTON COAL MARKET. Monday, Sept. 20, 1857.

(From the Boston Courier of Sept. 22.)

Coal—Duty—From all the British Provinces, N.A., free; from any other foreign country, 24 per cent.

The sales of English Cannel have been confined to small lots, at $12 75 a $13 75 per chal. cash. Sydney and Pictou have been quiet. Most of the Pictou arriving continues to be delivered on contract. Anthracite has been in good retail demand at $7 per ton, cash.

Cannel........chal	12 75 a 13 75	Sch'kill red ash........	5 75 a — —
Newcastle........none	— — a — —	do. lump........	6 00 a 6 25
Orrel........none	— — a — —	Lehigh, lump........	6 25 a — —
Sydney....mine chal........	7 10 a 7 25	Lackawanna........	5 50 a 5 75
Pictou.....mine chal........	7 20 a 7 25	*Retail Prices.*	
Pictou, fine mine chal........	5 25 a 5 50	Anthracite, white & red ash...	7 00 a — —
Sch'kill white ash, ton........	5 50 a 5 75		

LONDON METAL MARKET. Sept. 4, 1857.

(From the London Mining Journal, Sept. 5.)

COPPER.	£. s. d.
Copper wire........ p. lb.	0 1 3½ —
ditto tubes........ "	0 1 4– 1 4½
Sheathing and bolts.. "	0 1 1½ —
Bottoms........ "	0 1 2– 1 2½
Old (Exchange)......	0 1 0–
Best selected...p. ton.	124 10 0– —
Tough cake..... "	121 10 0– —
Tile........ "	121 10 0– —
South American "	— – —
IRON.	**per ton.**
Bars, Welsh, in London..	8 10 0– 8 15 0
do to arrive........	8 5 0– —
Nail rods........	9 0 0– —
do Stafford. in London..	9 5 0–10 0 0
Bars ditto	9 10 0–10 10 0
Hoops ditto	10 7 6–11 0 0
Sheets, single........	11 0 0–11 10 0
Pig, No. 1, in Wales......	4 10 0– 5 0 0
Refined Metal, ditto......	5 10 0– 5 15 0
Bars, common, ditto......	7 10 0– —
Ditto, railway, ditto......	7 7 6– 7 10 0
Ditto, Swed. in Lon......	14 10 0–16 10 0
in stock to arrive......	15 0 0–16 0 0
Pig, No. 1, in Clyde......	3 9 0– 3 9 6
Ditto, in Tyne and Tees..	3 11 0– 3 15 0
Ditto, forge........	3 10 0– —
Staffordshire Forge Pig...	4 15 0– 5 0 0
Welsh Forge Pig........	3 15 0– 4 0 0
LEAD.	
English Pig........	23 15 0–24 10 0
Ditto sheet........	24 15 0–25 0 0
Ditto red lead........	26 0 0–26 5 0
Ditto white........	27 0 0–28 10 0
Ditto patent shot........	27 0 0–27 10 0
Spanish, in bond........	23 10 0–23 15 0
American........	none.
BRASS (Sheets)....p. lb.	11½d.–12½d.
Wire........	11½d.–12d.
Tubes........	13½d.–14d.

FOREIGN STEEL.	per ton.
Swedish, in kegs........	22 0 0– —
Ditto, to arrive........	21 10 0–21 15 0
Ditto, in faggots........	23 0 0– —
English, Spring........	18 0 0–23 0 0
QUICKSILVER..... p. lb.	0 2 2– —
SPELTER	**per ton.**
Foreign........	31 0 0– —
To arrive........	31 0 0–31 5 0
ZINC.	
In sheets........	36 0 0–36 16 0
TIN.	
English, blocks........	140 0 0– —
Ditto, bars (in barrel).....	141 0 0– —
Ditto, refined........	144 0 0– —
Banca........	142 10 0–143 0 0
Straits........	141 0 0–142 0 0
TIN-PLATES.*	
IC Charcoal. 1st. qua. p. bx.	1 19 6– 2 0 0
IX Ditto, 1st quality, "	2 5 6– 2 6 0
IC Ditto, 2d quality, "	1 18 0– 1 18 6
IX Ditto, 2d quality, "	2 4 0– 2 4 6
IC Coke........	1 14 6– 1 15 6
IX Ditto........	2 0 0– 2 1 6
Canada plates....per ton.	16 0 0–16 10 0
In London; 20s. less at the works.	
Yellow Metal Sheathing, p. lb.	11½d. —
Wetterstedt's Pat. Met., p. cwt.	2 2 0
Stirling's Non-laminating, or Hardened, Surface Rails, p ton	9 0 0– 9 2 0
Stirling's Patent Toughened Pigs, Glasg.	— – 5 5 0
Ditto, Wales	4 0 0– 5 5 0
Indian Charcoal Pigs in London........	— – 7 10 0

REMARKS.—The tone of the market has not undergone any material change. The demand for most metals continues quiet, but prices generally are steady.

IRON.—The inquiries for rails are limited, and the amount of business doing in them at present is confined, in a great measure, to home railway companies. Exports of bars to the East are on the decline; also Staffordshire hoops, sheets, &c. The shipments generally about the last few months of the year gradually increase, but in consequence of the Indian mutiny the natives have ordered very sparingly. The demand, however, for other ports has rather improved.

* At the works 1s. to 1s. 6d. per box less.

Scotch pigs have been extremely dull, the market continuing very flat throughout the past week. Prices of most descriptions have declined about 1s. per ton from quotations of this day week, and the market closed heavily to-day at 68s., mixed numbers, warrants, cash; No. 1, 70s. 6d.; No. 3, 65s. 6d.; Coltness, No. 1, 78s. 6d.; Calder, 75s.; Gartsherrie, 77s.; Glasgow bars, f. o. b. in the Clyde, 8*l.* 12s. 6d. to 8*l.* 15s.; rails, 8*l.* to 8*l.* 5s. per ton.

Value of Metals, &c., imported into the port of New York for week ending Sept. 11th, 1857.

Brass and Bronze Goods	$9,323	do. other manufacture of	62,023
Chains	6,261	Lead	43,250
Coal	32,217	Metal Goods and Miscellaneous	20,121
Copper	9,282	Nails	2,778
Cutlery	52,919	Spelter	4,447
Guns	18,416	Steel	31,960
Hardware	32,612	Tin Plates	39,169
Iron Hoop	2,106	Wire	2,173
do. Pig	3,288		
do. Railroad	66,703	Total value imports	$549,118
do. Sheet	11,070		

Value of Metals, &c., exported from the port of New York, for the week ending September 14th, 1857.

Copper Ore	$21,900
Hardware	4,347
Machinery	37,135
Miscellaneous	6,864
Total Value of Exports	$69,646

NEW YORK METAL MARKET. Sept. 23, 1857.

Iron.				
Pig, No. 1, Scotch	$27	a	29	6mos.
" 1, Anthracite	26½	a	28	"
" 2, "	25	a	26	"
" 3, "	..	a	24½	"
" 1, Charcoal	29	a	35	"
Bar, refined	62½	a	67½	"
Common English	53	a	58	"
Band	72½	a	75	"
Hoop	72½	a	77½	"
Spike Rods	60	a	65	"
Railroad Bars	52½	a	57½	"
Boiler Plate, English	3¼	a	3½c	"
" Amer	4	a	5½c	"
Sheets, Russia	11	a	12c	"
" English, singles	3¼	a	3½c	"
No. 24	4	a	c	"
Steel.				
Cast	14	a	15½c	"
English Spring	100	a	110	"

Nails, cut	3¼	a	3½c.	6 mos.
Wire, bright & an	50	a	55	"
Telegraph	5¼	à	5½c	cash.
Tin, Gov't, Banca	33½	a		"
Straits	32½	a		"
Tin-Plates.				
I X Charcoal	11½	a	11¾	6 mos.
I.C. Coke	10			"
Ternes, I.C.14x20Char.	10½	a	11	"
" Coke	9	a		"
Zinc, sheet	9	a	..	"
Spelter	7¼	a	7½c	"
Lead.				
Refined Eng. & Ger.	6¼	a	6½	cash.
Soft Spanish	6	a	..	"
Copper, Ingot	24	a	..	"
Sheathing	28c			6 mos.
Copper				
Yellow Metal Bolts	26c			
Refined Ingot we note sales of 25,000 lbs. Lake Superior at	24½			cash.
50,000 lbs Chili Pig	24			6 mos.
Antimony	12c	a		cash.

BOSTON METAL MARKET. Sept. 21, 1857.

(From the Boston Courier.)

The market for Scotch Pig Iron continues dull, and the sales have been moderate at $28 per ton, 6 months, for Gartsherrie and other brands No. 1; and American Pig at $26 a $27 per ton, 6 months. Bar iron is quiet, with sales of common and refined English at $55 a $65 per ton. In Russia Sheet, small sales at 11¼ a 11½ per lb., 6 months.

Russia P. S. I. Old Sable per ton of 2,240 lbs., 6 mos	.. ..	a	.. ..
do. New Sable	.. ..	a	.. ..
Swedish, ass'd com	100 00	a	105 00
Square and extra sizes	110 00	a	117 50
Eng. round, flat and square	57 50	a	60 00
Eng. round, refined	67 50	a	70 00

Scotch pig. 1st quality	28 00	a	29 00
do other qualities	27 00	a	28 00
American pig, No. 1	26 00	a	27 00
Russia Sht, pl'd, per lb	..11¼	a	.. 11½
English do	.. 4	a	.. 4½
Penna. boiler, 1st qual	.. ..	a	.. ..
do 2d do	.. ..	a	.. ..
Brandywine do. best	.. 5¼	a	.. 5½

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

SCHUYLKILL.

The quantity of coal sent by railroad and canal from Jan. 1 to Sept. 19, 1857, is:—

	Tons
By Railroad	1,898,193
" Canal	874,984
Total by Canal & R. R.	2,273,177

Shipments to same period last year:

By Railroad	1,596,281
" Canal	776,960
	2,373,241
	2,273,177
Decrease in 1857, so far	100,124

LEHIGH COAL TRADE FOR 1857.—*From Miner's Journal, Pottsville.*

Total amount of shipments for 1857, to Sept. 15th:

By Canal,	Tons.
Lehigh Coal and Nav. Co.	265,543 13
A. Lathrop and others	2,107 12
Spring Mountain Mines	24,294 12
East Sugar Loaf do	16,432 06
Coleraine do	35,487 14
Stafford do	510 11
N. York and Lehigh Coal Co.,	20,994 15
German Penna. Coal Co.	7,071 00
South Spring Mountain Coal	12,382 13
J. B. McCreary & Co. N. S. Mt. Coal	8,348 01
Beaver Meadow Coal Co.	1,108 18
Hazleton Coal Co.	65,965 00
Cranberry Mines	45,495 17
Diamond Mines	18,743 12
Council Ridge	23,955 00
Mt. Pleasant Coal Co,	4,612 00
Buck Mountain Coal Co	49,138 06
Wilkesbarre Coal Co.	700 05
Wyoming Coal	8,406 09
Hartford Coal Co.	17,365 14
Total	628,663 18

LEHIGH VALLEY R. R.

Spring Mountain Mines,	89,103 12
East Sugar Loaf do	72,022 00
N. York & Lehigh do	27,309 18
Council Ridge do	47,384 02
German Penna. do	6,307 19
Coleraine & Stafford do	36,761 13
Dolbin & Dehaven do	6,988 03
Hazleton do	36,931 06
John B. McCreary & Co	4,712 03
	327,520 18
	628,663 18
Total	956,184 16

Shipments during same period, last year:

By Railroad,	104,513 19
By Canal	817,516 04
	922,030 03
	956,184 16
Increase in 1857, so far	34,154 13

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the Month of August, 1857:

	Month.	Total.
Union Canal	16,498 18	115,223 07
Swatara Railroad	12,534 09	85,782 16

LYKENS VALLEY COAL TRADE FOR THE WEEK ENDING AUG. 1, 1857.

Lykens Valley Coal Company	1,588 tons.
Previously this year	4,215 00 "
Short Mountain Co. for week	
Previously this year	354 31 "
Total	77,487 "

LACKAWANNA COAL TRADE.

Coal transported over the Delaware, Lackawanna, and Western Railroad for week ending Saturday, Sept. 12th, 1857:

	Week.	Season.
Shipped North	5,441	152,293
" South	8,890	236,244
Total	14,331	388,537
Coal shipped to the same period last year		43,393

DELAWARE AND HUDSON CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Sept. 15	278,084
Last year	319,208
Decrease this year	41,194

PENNSYLVANIA COAL CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Sept. 15th	416,873
Last year	402,765
Increase so far, this year	14,108

TREVORTON COAL TRADE FOR 1857.

	Tons.
Up to Sept. 7th	66,968

BROAD TOP COAL TRADE FOR 1857.

	Tons.
Up to Sept. 15th, 1857	48,727

MARYLAND COAL TRADE.

Shipments of coal for the week ending Saturday, Sept. 12th, 1857: By the Cumberland Coal and Iron Company's Railroad.

	Week.	Year.
Cumberland Coal & Iron Co	1,199	108,770
Hoffman Mines	216	3,756
Ætna Coal Co	125	11,995
Total	1,540	123,592

By Cumberland and Pennsylvania Railroad:

Frostburg Coal Co	113	18,970
Borden Mining Co	383	18,970
Union Coal Co.	72	29,895
	570	97,553

Total from the Frostburg region for the week, 2,112 tons; and since January 1st, 221,055 tons.

By the George's Creek Coal and Iron Company's Railroad.

	Year.
Franklin Coal Co.	30,789
Barton Coal Co.	425
Swanton Coal and Iron Co.	3,433
Pickell Coal Co.	4,329
American Coal Co.	68,273
C. E. Detmold	21,315
George's Creek Coal and Iron Co.	54,470
Total	183,437

By the Hampshire Coal and Iron Co's. Railroad.

Hampshire Coal & Iron Co.	44,026

Total from George's Creek region for the week, 800 tons; and for the year, 227,464 tons.

Total from the whole coal region for the week, 2,912 tons; and for the year, 448,519 tons.

ANALYSIS OF MICHIGAN COAL.

Prof. S. H. Douglass of the State University communicates to the Peninsular Journal of Medicine the subjoined article concerning Michigan coal and its value in making gas:

As wood and oil advance in price, whatever relates to the coal of Michigan assumes an increased importance to the people of our State. Having recently made an analysis of coal from the coal bed of Mr. Hayden, near Jackson, I deem it a matter of sufficient importance to make the result public. The analysis had particular reference to the value of the coal for the manufacture of coal gas.

The coal was of the bituminous variety, having a jet black color and slaty structure. It was readily ignited, burning with a dull flame and much smoke, the fragments comminuting more or less by the heat. It had a specific gravity of about 1.25.

100 parts gave:

Volatile Matter	50 780
Sulphur	4 028
Iron	4 400
Ash	8 400
Carbon (not volatilized)	41 600

The value of coal for the manufacture of gas is usually estimated by the amount of volatile matter it yields at a full red heat. The following list of English coals, taken from the best authorities, are given in the order of their gas-producing properties, as determined by actual trial, for the purpose of comparison:

	Volatile Matter.	Ash.	Sulphur.
Boghead	68· 4	22· 8	1·06
New Brunswick Canal	66· 2	· 6	·14
Kirknep	60·	13·	2·80
Staffordshire Canal	50·	2·	2·60
Arniston	45· 8	4· 2	3·40
Silkstone (Yorkshire)	38·	2· 6	2·20
Wigan, (Lancashire)	37·	3·	2·40
Ramsey, (Newcastle)	36· 8	6· 6	2·50
Nielsea, (Somerset)	34· 9	3·	5·70
Coal Pit Heath	30· 1	5· 8	3·20

It is apparent from the above that the amount of volatile matter in the coal holds a fixed relation to its gas-producing properties.

The following table, compiled from Prof. Johnson's work, will show the volatile matter in the several varieties of American coals. The sulphur is not given in these analyses, but there is no reason to believe that it will be very much less than the average of any coals:

	Volatile Matter.	Ash.
Beaver Meadow, Pa.	3·30	7·11
Peach Mountain, Pa.	3·07	4·41
Lehigh, Pa.	5·28	5·56
Cumberland, Md.	14·67	14·98
Blossburg, Pa.	14·78	10·77
Midlothian, Va.	37·28	10·47
Canelton, Ind.	33·99	4·97
Pittsburg, Pa.	36·78	7·07
Jackson (by Prof. D.)	50·78	8·40

From the above it will be apparent that the coal of Michigan for the manufacture of gas is nearly equal to the best English coals, and quite superior to any of the American coals around. I have not access to analyses of the Ohio coals, and am not aware that any have been made.

COAL IN THE IMMEDIATE VICINITY OF LANSING.

Mr. Silas E. Millett has deposited in our office several specimens of coal of a superior quality, taken from his farm situated in the township of Delta, about four miles up the Grand River from this place. From the explorations that have already been made, there is not the slightest doubt but that coal is there deposited in extensive quantities. Its location on the river will afford easy shipment down stream to this place. Mr. M. purposes to make more extensive investigation, and operations immediately.

Between the strata of coal is deposited the purest clay, which is now being used in manufacturing, in this village, an excellent article of stone-ware.—*State Journal.*

POTOMAC COAL AND IRON COMPANY.

This Company, located in the Valley of George's Creek, has just completed its two incline planes and the tram-road connecting the colliery of the company with the Railroad of the George's Creek Company, at Barton. All the other improvements, appliances and facilities are also completed, and the Company can at once transport over its planes and road full five hundred tons per day with perfect ease. The machinery and wheel-house are constructed on a novel plan, devised by William Brace, Esq., civil engineer to the Company, and work most admirably. The dump-house is supplied with one of Lowne's patent dumps, a capital invention.

The Company owns about three hundred acres of George's Creek land, near one hundred acres of which is underlaid with the great, or "fourteen feet" stratum of coal. The vein is opened at a distance of about one mile from Barton, the point of intersection with the George's Creek Railroad, and the means of conveyance of the coal from the colliery is the two incline planes and tram-road alluded to. The loaded cars descend to the dump-house over the tram-road, by their own gravitation, horses being used only in the ascent of the planes.

The Company contemplates sending coal to market in a brief period.—*Cumberland Telegraph.*

DISCOVERY OF COAL IN LOUISIANA.

A coal-field is said to have been lately discovered near the Ouachita river in Louisiana, which promises most favorable returns. Another is mentioned

near the Big Black on the dividing line between Claiborne and Hinds counties, Mississippi, about eighteen miles east of Vicksburg, and in the vicinity of the New Orleans and Jackson railroad. Says the New Orleans Delta:

"Coal is but a part of the mineral and other treasures discovered on these lands. The stratum of coal, which is about four feet thick, is said to be interspersed with rich veins of iron ore, and both these articles were discovered in digging a well which contains the finest chalybeate water. On the same ridge of land in which these discoveries are made, Cooper's Well and Mississippi Springs are situated. It extends through Claiborne, Hinds, and Madison counties, and has been long known to be rich in iron ore as well as other minerals.

"Thus we see that geography and geology both combine to furnish an abundance of the most needful elements of commerce, manufacture, and internal improvements, almost at our doors. Nothing but intelligent enterprise is wanting to bring to a brilliant completion what nature has so lavishly begun."

The Picayune adverts to the receipt of nearly a hundred barrels of the Ouachita coal at New Orleans, which was at once submitted to the severest tests for every description of use, in furnaces, grates, stoves, or steamers, etc., with entire satisfaction.

From a pamphlet which has been laid on our table, by Henry Colton Morris, Esq., as well as from facts within our own knowledge, we are assured that recent discoveries of coal on the Upper Ouachita, by Mr. Morris and others, will prove an invaluable blessing to New Orleans and all portions of the Lower Mississippi. In extent, the Ouachita coal embraces hundreds of square miles with an average thickness of vein of from five to seven feet. The coal is of the "brown" or "lignite" variety, and similar to the celebrated Torbain Hill coal of Scotland, which, being too valuable for fuel, has for several years past been exclusively used in the manufacture of gas and illuminating and lubricating oils. On the English and French railroads, the oil made from this coal is now used in preference to the best descriptions of sperm oil.

Professor Riddell, who analyzed the Ouachita coal, has declared that, "it cannot fail, so far as quality is concerned, to give entire satisfaction as a fuel for domestic uses. It is also well adapted for the production of steam in stationary engines and on river steamboats." The Professor also states that there is but a shade of difference between it and the Torbain Hill coal. This opinion is fully confirmed by Mr. Glover, of Pennsylvania, both the Torbain Hill and the Ouachita mines, the former with a view of ascertaining all that could be learned concerning the manufacture of mineral oil, and the latter for the purpose of ascertaining the practicability of working the mines with advantage in order to supply the New Orleans Market.—*De Bow.*

LACKAWANNA COAL REGION.

The following view of the interests of the Wyoming Valley, taken by the editor of the Pittston Gazette, is really applicable to all other coal regions; and in consideration of the present depressed condition of the coal trade, we commend it to all those who are desirous of relieving the trade from its embarrassing circumstances.

Since our advent in the Valley of Wyoming, we have regarded with deep interest, the prospects of the various pursuits, by which we are surrounded, and have watched with some anxiety the depression of our chief business. The capital invested in the coal business amounts to many millions of dollars, and as yet no regulations exist whereby the several operators are governed. Thus far this immense business has been conducted in a hap-hazard manner, whilst almost all other pursuits in which less interests are involved, are so

managed as to avoid ominous competition. While iron is selling at higher rates, the price of coal is 25 cents per ton less than it was one year ago, and simply because men can be found reckless enough to supply consumers at the present low rates. Operators complain of their inability to pay expenses, and yet continue to do that which they feel must eventually end in disaster and ruin. It is fair to presume from the reports of the various geologists that our coal field contains upon average thirty feet of coal, producing, according to experience, one thousand tons per foot in thickness, or in other words, 10,000 tons of clean coal per acre. This, at a mine rent of five cents per ton, would yield the owners at the rate of fifteen hundred dollars per acre, and yet we venture to assert, that when they are worked by the owners, they do not pay three per cent. upon the investment, unless in a few favored locations; and further, that the profits on the entire coal business of the County of Luzerne, does not at the present day pay one per cent. upon the estimated value, nor one-half per cent. upon its real value. We do not wish to be understood as discouraging investment in coal lands or coal companies, on the contrary, we believe that it is the safest and best that can be found. We are satisfied that if the business could be conducted with any degree of unanimity, it would be shown that the present estimate estimate of coal lands is much below their intrinsic value. To accomplish such a result no one thing would conduce more than the establishment of a Board of Trade or Coal Exchange. By such an arrangement an interchange of ideas would serve as a guide for future action. It would do away with the necessity of combinations, which are never productive of good, and at the best, are but of short duration. Penalties incurred under a combination, even if agreed upon, cannot be enforced. Interest alone govern men in business, and so long as they are thus governed, they must be shown where their true interests lie, and this can only be done by direct communication between the parties to be benefited. That the business can be made remunerative is certain—that it should be all will concede, and that some basis must be agreed upon, or a majority of our operators become hopelessly involved, is equally sure. We do not discriminate between different localities, for so far as our observation extends no one point in the valley possesses greater advantages than another. The Anthracite Coal Trade of Pennsylvania commenced in 1820, in which year only 365 tons of coal was sent to market, and the average per year for the first 5 years of the trade amounted to only 3,809 tons. From that time until the next term of 5 years the average shipments amounted to 67,194 tons. The next five years we find the average 315,961. The next term of five years the demand reached the average of 736,656. In 1842, for the first time, the business reached a million of tons in one single year; and the average from 1839 to 1845 (that being the next term of 5 years), we find the sales amounting to 1,165,504 tons. The average for the succeeding term of 5 years is more than double that of the last term—amounting to 2,736,226 tons. The next term of 5 years brings us to the year 1855, in which the average annual amounts sent to market is 4,685,001 tons—being an increase over the preceding period, of one million, nine hundred and forty-eight thousand, seven hundred and seventy-five tons, or an average annual increase of 389,755 tons. We find that the amounts sent during the year 1855 is 6,552,301 tons, and in 1856, 6,751,542 tons, amounting in the aggregate to 13,303,843 tons, being an increase of 2,435,983 over the preceding two years of '53–'54. The same ratio of increase allowed for the coming period of 5 years, beginning with the year 1855, and ending with 1859, will create an average demand for not less than 9,000,000 of tons per annum. That this demand will arise is certain, for our conclusions are not the result of speculation—*facts* which cannot be controverted fully establish them. As before stated, the demand for coal in 1842, was only 1,108,001 tons; in 1856 we find it 6,751,542. Who can predict the demand for a corresponding period of fourteen years? Our statistics do not embrace the quantity sent to inland towns. Let that be added to the delivery of 1856, and the amount will fall little short of 7,850,000 tons for the last year. The

amount sent from our county in 1856 to a market was about 2,000,000 tons, and the present year it will be increased probably to 2,500,000 tons—owing to the completion of the L. & B. R. R. and Del., L. & W. R. R. Co.'s tracks to Elizabethport and Jersey City, to produce which not less than 178¼ acres of land is annually exhausted, and as a general rule those lands most favorably located are the ones worked, and indeed it must be so in the face of the present system, of "every one for himself and the devil take the hindmost."—It would seem that those who own lands more favorably located than their neighbors are striving to drive them out of the market by reducing the price of the coal to so low a figure that the business cannot be done without an actual loss to the operator, who in turn must stop his works, wherein he would suffer serious loss, or continue business with the same prospect before him. As a general thing they choose the latter, preferring to suffer the loss by a depreciation of price instead of stoppage, which in its turn compels those who will not give them a chance for fair prices, to still farther reduction.

IRON AND ZINC.

THE IRON TRADE, PAST AND PRESENT.

Mr. Rich. Cort has forwarded us a large amount of valuable statistical information, showing the gradual and enormous increase which has taken place in the iron trade in the last half century. It appears that the export of British iron of all sorts, and steel during the 38 years ending 1829, amounted to 30,311,025*l.*; whilst in the 27 1-2 years following, five times that value was exported, or to the amount of 149,654,320*l.*, making a total for the 64 1-2 years of nearly 180,000*l.* The hardware and cutlery trades fully maintain their position, notwithstanding the largely increased make in France, Germany, and other foreign countries. In the 16 years ending 1829, the export was 26,264,550*l.*, against 59,130,314*l.* for the following 27 1-2 years. In the machinery and steam-engine trade the increase has been immense, the exports amounting to but 1,557,643*l.* for the eight years ending 1829; whilst in the succeeding 27 1-2 years they amounted to 23,584,912*l.* The total make of pig iron from 1788 to 1856 inclusive, was 60,026,995 tons; and it may be assumed that 30,000,000 tons of rolled iron, allowing for waste, was made from this quantity of pig iron. Mr. Wm. Routh, formerly in partnership with the late Mr. Richard Crawshay, and now managing Director of the new British Iron Company, stated in 1812, that "the contract price for the Swedish ore ground iron of the first marks had never, within the previous 10 years, been under 35*l.* per ton, and had varied from that to 40*l.*, the last being 37*l.* 6s. 8d., from which deducting 6*l.* 13s. 4d., the duty paid here, left 30*l.* 13s. 4d. per ton as the outgoing upon every ton so contracted for. The British iron, which had been found of a quality sufficiently good to supersede the necessity of importing the other for the use of the navy, had been contracted for at 20*l.* to 28*l.* per ton; and calling the average price 24*l.*, the saving to the country, speaking of the Navy Board only, was 12*l.* 6s. 8d. per ton, and to the country at large 30*l.* 13s. 4d., per ton, because the total cost of the British iron was composed of materials abundant and otherwise useless here, and of British labor. Every ton of iron used in the Navy was rolled with Cort's patent grooved rollers. The ore ground iron was then lower than it was when Government was the principal consumer, but if their consumption were re-established, the price would be the same as it was before. The late Mr. Richard Crawshay signed a contract to pay 10s. per ton for all iron rolled un-

der Henry Cort's patent, but the firm have since rolled the best part of 2,000,000 tons, and have never paid one farthing—the patents having been illegally seized by the Treasury of the Navy in 1789, and the iron trade suffered to work under them for nothing. The imports of foreign iron having gradually decreased since the introduction of Mr. Cort's processes, it is calculated that the total benefit secured to the country is equal to 1,200,000,000*l*.

STATISTICS OF THE SCOTCH IRON TRADE.

Works.	Proprietors.	In blast	Out of blast	Total
Gartsherrie	Wm. Baird & Co.	15	1	16
Eglinton	ditto	5	..	5
Blair	ditto	3	2	5
Lugar	ditto	2	2	4
Muirkirk	ditto	1	2	3
Glengarnock	Merry and Cunningham	7	2	9
Ardeer	ditto	4	..	4
Carnbroe	ditto	4	2	6
Coltness	Coltness Iron Company	8	..	8
Dalmellington	Dalmellington Iron Company	4	..	4
Monkland	Monkland Iron and Steel Company	8	1	9
Langloan	Addie, Miller, and Rankin	5	1	6
Summerlee	Wilson's & Co.	6	..	6
Dundyvan	John Wilson's Trustees	6	2	8
Clyde and Quarter	Colin Dunlop & Co.	5	4	9
Govan	Wm. Dixon, Esq.	4	2	6
Calder	ditto	5	3	8
Omoa	Robert Stewart, Esq.	3	1	4
Shotts	Shotts Iron Company	3	1	4
Castlehill	ditto	3	..	3
Portland	Lancaster, Cookney & Co.	4	..	4
Kinnell	William Wilson, Esq.	4	..	4
Forth	Forth Iron Company	6	..	6
Lochgelly	Lochgelley Iron Company	3	..	3
Lumphinan	A. Christie & Co.	1	..	1
Carron	Carron Iron Company	3	1	4
Down	James Miller, Esq.	1	2	3
Almond	James Russell and Son	2	..	2
Gladsmuir	C. & A. Christie	1	..	1
Garscube		..	2	2
Nithsdale		..	3	3
Total		126	34	160

Stock on hand, Dec. 31, 1855	98,000	tons.
Stock in warehouse-keeper's and makers' stores, Dec. 31, 1856	88,000	"
Decrease of stock	10,000	"
Exported foreign and coastwise, from Glasgow, Firth of Forth, Ayrshire ports, and per railway	502,000	"
Consumed in local foundries and malleable iron works here	340,000	"
Total deliveries	842,000	"
Deduct decrease in stock	10,000	"
Computed make in 1856	832,000	"

	Furnaces in blast.	Make.	Consumption.	Stock.
Dec. 31, 1845	88	475,000 tons.	390,000 tons.	245,000 tons.
" 1846	98	570,000 "	666,000 "	149,000 "
" 1847	100	510,000 "	579,000 "	80,000 "
" 1848	103	580,000 "	562,000 "	98,000 "
" 1849	112	690,000 "	578,000 "	210,000 "
" 1850	105	595,000 "	535,000 "	270,000 "
" 1851	112	760,000 "	680,000 "	350,000 "
" 1852	113	775,000 "	675,000 "	450,000 "
" 1853	114	710,000 "	950,900 "	210,000 "
" 1854	117	770,000 "	860,000 "	120,000 "
" 1855	121	825,000 "	847,000 "	98,000 "
" 1856	126	832,000 "	842,000 "	88,000 "

IRON MINES OF LAKE SUPERIOR.

The iron mines of Lake Superior are certainly beginning to assume a prominent position. A correspondent of the *Lake Superior Journal*, in a communication to that paper, speaks as follows of the iron manufacture in that region:—

The iron mines of Lake Superior are quite as deserving of remark as those of copper. The latter are, however, better known than the former, and I propose in this letter, to give the reader a birds-eye sketch of the iron mines, and the mode of working them.

The nearest accessible point to the iron range from Marquette, is 12 miles. The range is elevated some nine-hundred feet from the lake. It will gratify every friend of the extension of our inland commerce in general, and every true-hearted citizen of Michigan in particular, to learn that the northern link in that grand chain of railroad which is to connect Lake Superior direct with the great marts of the west, is now nearly completed. By the first of September, I think we shall see the steam locomotive, that great civilizer and aid to commerce, puffing its way the whole distance to the iron mountain. The road is all graded and most of the rails laid down. Already two fine engines are here waiting for service. As soon as the road is in running order, it cannot fail to do a remunerating business. There is a great demand for Lake Superior iron this season, and while I am writing, I can look out of my window at the Marquette House, and count thirteen vessels, all waiting for iron. The Sharon and Cleveland Companies—the only parties who are mining to any extent at present, find it impossible, with the facilities for transportation, to which they are now limited—a plank railroad operated by horses—to supply the demand. The completion of the steam railroad to the mountain will be the commencement of a new era in the mining enterprises of Lake Superior. I have no doubt, if vessels can be found to transport the mineral from Marquette, that the business of mining will be doubled, to say the least.

When the visitor comes at the iron range, he cannot fail to be astonished, however perfectly he may have informed himself in respect to the quality of the ore and the unlimited quantity in which it is found—*and the facility with which it can be mined.* The range is broken up with hillocks, of greater or less extent, and it is these hillocks that are only worked. Of course there is a vast amount of iron below the surface; but this, such is the comparative ease of mining from the side of a hill, is left untouched, and will be considered, doubtless, of no practical account, until the hills are exhausted, an event not likely to happen for centuries to come. Those who have been familiar with mining operations, are scarcely prepared to see a company of thirty or forty miners all at work above ground. It is difficult to dissociate a mine from the realms of Pluto, or a miner from a sort of ground mole, with a lighted candle growing out of his head. But the operations here are all conducted in broad daylight. Indeed, the system of mining is little less than quarrying.

It has been asserted by some wise ones—wise at least in their own conceit—that the prosecution of the iron interests of Lake Superior could never be made, to use an expressive Americanism, to pay, and the same Solomons have denounced the scheme of a railroad from Lake Winnebago to Marquette, because the iron interests, not being remunerative, were almost the only sources on which the road could depend, for freight. I suppose that the directors of the Chicago, St. Paul, and Fon du Lac Railroad, can take care of their own concerns, and doubtless they will do so without any help from me. But if the task of demolishing these croakings devolved upon me, I should regard it as mere child's play. First, as to the matter of the loss or gain resulting to the iron companies from the working of the mine. There is a clear net profit now, with the present bungling and inadequate facilities for hauling the mineral to the pier at Marquette, of nearly three dollars per ton, and the profit must be not a little increased after the completion of the railroad.

But secondly, granting, if you please, that, in the event of the construction of the contemplated railroad, the ore, though it may be made profitable by the parties interested if transported by the lakes, nevertheless contains too large a per cent. of refuse in proportion to its value to be economically carried by railroad, no one will pretend to urge such an objection to iron in pigs, and there is every reason to believe at no distant day, pig iron will be largely manufactured in this region. For myself, I am convinced that the true plan is to smelt the mineral on or near the ground. The experiment has never been thoroughly tried as yet, though in the absence of any trial, it would seem to be a sufficient demonstration of the expediency of the plan, that the actual cost of making charcoal pig iron here, is only a trifle greater than that of making it in Cleveland or Detroit, while, in the matter of transportation, the manufacture on the spot would of course have a decided advantage over his rival elsewhere. But theories aside, we shall soon have the problem solved conclusively. An experiment is about to be made on a large scale. The Pioneer Iron Company, organized last winter, through the energetic efforts of Charles T. Harvey, Esq.,—a name which has been long associated with the development of the resources of Lake Superior—will complete their blast furnace early in the coming winter. Soon after which, if they are successful, as I think they are almost sure to be, there will be many more enterprises started of a similar nature. I am heartily glad, therefore, to perceive that this Pioneer Company are thoroughly in earnest. I visited the site of their establishment last week, for the second time, and found that they were driving forward their work in a truly western style. They are building two stacks, and their furnaces will be capable of producing twenty tons of pig metal per day. When I first visited the spot, five weeks since, it was almost a wilderness, with scarcely a shanty to be seen. Now, an extensive clearing has been made, and quite a village of frame houses—in the rough of course—has sprung up. The company have made extensive provisions for a supply of charcoal. They have purchased 4,000 or 5,000 acres of timber lands contiguous to the Sharon Mine, near which their establishment is located. If they should fail, their failure cannot certainly be attributable either to any want of funds or of efficiency in the management of the business. The capital of the company is $125,000, of which $50,000 have already been called in for instalment, and mostly expended. The President and Directors are men well known on Lake Superior, four of them (including Mr. E. C. Hobarts, whose name alone is a host,) being directors in the Minnesota Copper Mining Company. A very favorable contract has been made for the supply of ore with the Sharon Iron Company, and every thing seems to foreshadow complete success.

MINERAL EXPORTS OF GREAT BRITAIN.

The largest amount of export trade done during the month by the mining interests, or such branches of England's industry as are dependent on mining enterprise, was with the United States. The aggregate value was 447,203*l.*, the heaviest items being bar-iron, cutlery, and tin-plates. Next in precedence of value comes the East Indies, to which were transmitted goods to the cost of 241,997*l.*, in which bar-iron likewise presented the principal feature, and then machinery, sheet copper, and wrought-iron. Our allies, the French, take the third place in the scale of transactions, and required imports into their country from our productions to the amount of 177,648*l.* in which the payments for coal, pig-copper, and pig-iron occupy the principal figures. Within 60,000*l.*, value of our commercial relations with gigantic France comes the little colony of Australia, which stands fourth in trading importance. The value of the exports, for Australasia generally, we presume, is declared at 117,669*l.*; in which hardwares and cutlery absorb nearly one-third, and bar and wrought iron about one-half; the first was equal to 35,945*l.*; the second

to 26,798*l.*, and the third to 25,767*l.* Holland follows Australia, and takes 59,412*l.*, of which more than one-half was paid for pig and wrought iron, nearly a sixth for bar-iron, and about a seventh for sheet copper. Hanse Towns run close on Holland, paying 59 810*l.*, which is within 1,600*l.* of the latter. Here bar-iron is the principal article transmitted, and is followed in value by hardwares and cutlery, when come sheet copper and coal, which latter two each represent nearly one-sixth of the whole. Spain takes the seventh place, but drops the total to 40,780*l.*, which consists of three items—namely, 15,928*l.* for coal, 15,688*l.* for steam-engines and parts; and 9,164*l.* for other sorts of machinery. We again knock off nearly one-half of the aggregate value when we come to Brazil, which is next in order and absorbed the value of 24,890*l.*; consisting of coals to the extent of 15,539*l.*, sheet copper 6,835*l.* and cast-iron 2,016*l.* Our chivalrous friends the Sardinians received the value of 15,227*l.*, and stand ninth in the list of sixteen principal places of trading connection during February. This sum was made up in two items—namely, 14,853*l.* for bar, and .74*l.* for cast-iron. Belgium took to the value of only 9,744*l.*, all in copper; 6,510*l.* being for pig, and 3,234*l.* for sheet. To Belgium succeeds Denmark in one item of 9,695*l.* for coals; and then follows Prussia, to the amount of 8,338*l.*, in bar-iron, for 4,321*l.* and coals for 4,017*l.* Canada comes in the thirteenth place, and absorbed goods to the amount of 8,106*l.* in seven different items, the principal being for cast-iron. The West Indies merely required coals, which were shipped to the value of 5,491*l.* Malta, likewise, dealt with us only in the same article, during February, for the sum of 4,878*l.*; and Turkey took coals exclusively to the declared value of 4,600*l.* These, our allies of the Crescent, close the list of specified nations with which we have traded, and under "other countries" is accumulated an aggregate total of 667,081*l.*, as mentioned at the commencement of these remarks. The heaviest portion of this was for wrought-iron, to the extent of 127,363*l.*; then succeeds bar-iron, to 103,348*l.*; cutlery, 87,335*l.*; coals, 84,834*l.*; and so on through all the different materials of which the general exports consisted. These figures are large, and if they had been subdivided would have rendered the returns very complete. Russia, it will be observed, for instance, is not enumerated; and it seems possible that she may be included in "other countries." The Italian states do not appear; yet it is understood that there is considerable business now going on in iron, and other necessary articles for railways. Sweden and Norway are likewise omitted, as are also Portugal, Naples, Sicily, the South American States, and many other places.

These remarks show that our exports of metals and metallic manufactures to the four first-named places are equal to an annual value of 11,817,492*l.*, of which the United States takes to the extent of 5,366,424*l.*; East Indies, 2,903,964*l.*; France, 2,131,776*l.*; and Australia, 1,415,628*l.* Our colonies—those which are enumerated—namely, the East Indies, Australia, Canada, West Indies, and Malta, absorbed goods to the collective value of 378,441*l.* during the month, equivalent, consequently, to an annual trade of 4,541,292*l.* in value. Facts like these require but little comment—they declare their own importance, and bear incontestable evidence of the extraordinary increase which is continually going on in all matters associated with the mining interests of this country. Immense importance—indeed the absolute necessity to this country's welfare—attaches to the proper development of all our mineral localities. If Great Britain is to maintain its position in her commercial relations with foreign countries, encouragement and support must be afforded; for however much the ignorant and narrow-minded may desire to depreciate the value of mining within these realms, it is nevertheless most true that the results thereof absorb one-fourth of the entire exports of the gigantic shipments from our shores.

This subject has not escaped the attention of Members of the new House of Commons in their addresses to the electors. This clearly indicates the feeling on the question throughout the land, which is not confined to England,

but extends to Scotland and Ireland. Where would Glasgow now be in her mercantile influence if mining had not been encouraged in her vicinity; and such is the wealth and power derived by it from that source alone, that there is every probability of her becoming one of the greatest cities in the world, as she is already the true capital of Scotland. Ireland presents a wide field for similar enterprise, and it is, therefore, with satisfaction we find that Mr. John Alexander, in his address to his constituents in Carlow, specially alludes to the mineral wealth of our Sister Isle. "The economic expenditure," says this gentleman, "of all public moneys, the reduction and final extinction of the income tax in 1860, the promotion of trade and commerce, the improvement of agriculture, the development of Ireland's vast resources, *mineral* and other; the extension of her railways into all countries; these and other important matters should command the attention of every member of the Legislature."

THE IRON MOUNTAINS OF MISSOURI.

The immense mineral resources of the State of Missouri are not appreciated or generally known as well as they should be. The following description of the *Iron Mountains* was furnished by a correspondent to the *St. Louis Republican*, and will give a very adequate idea of the value of those immense deposits of iron ore.

The name of this place, on the map, indicates its character; and so much has been said about it that it is generally well known. that is, it is known that there is a mountain of iron ore existing there, called by that name; but not much is known abroad of its real character. It is generally supposed that it is a vast mass of iron ore, with a few scattering stinted trees and shrubs upon it; but while the former is the case, the latter is not so, as it is covered by a forest of trees as large and thickly standing as on other elevations in that section of the country. It is about a *mile and a quarter* in length, and *three-fourths* of a mile in breadth, as I was informed there, and rises gradually on the sides to an elevation of about two hundred feet above the level of the valley around. This will make the base about four miles in circumference. It is an oblong, extending north and south. All this is *one immense mass of iron ore*, of the richest quality known in the world! The ore is found lying on the surface, almost as "thick as it can stick;" but as the mountain is penetrated downward, it is found to consist of immense solid masses. How deep it exists is unknown, as the earth has been bored at the base to the depth of sixty or seventy feet, for water, and the ore still found to continue! Such is the immense quantity of ore contained in this mountain, that, after *three furnaces* have been running ten or eleven years, and after the hauling away of immense quantities, which still continues, there has been scarcely any perceptible impression made on it, *even on the surface*, while below it remains almost untouched, as none of the ore has been blasted out except at one small place. By taking the ore from the surface, which is generally in small pieces, the labor of blasting it out and having it broken up for the furnace is saved. The ore is of so pure a quality as to yield from eighty to eighty-five per cent., but the yield from the furnace in smelting is about fifty-six per cent. It requires about seventy pounds of limestone to every eight hundred of ore for fluxing. An idea of the purity of the ore can be formed, when I state that at Valley Forge, about three miles east of Farmington, after the usual process of "roasting," as it is called, to render the ore more friable, it is put into the furnaces and made directly into blooms, without first having, as is usual with iron ore, to be taken through a large furnace and made into the "pig" metal; and I have seen specimens of it so pure as almost to resemble the metal itself in appearance. The scarcity of fuel is a great obstacle in the way of the profitable manufacture of iron at the Mountain, as there are no mines of stone coal near enough to use that, and, owing to the rocky character of the count-

try, the timber for fuel is small and scattering. The quantity of iron in this remarkable mountain is almost incalculable. It has been *said* to contain enough to last the *whole world* for all future time; and at the present rate of consuming the ore, it must take ages to exhaust it, *even on the surface!* But much as this is, it is but a portion, and not a large one at that, of the iron ore of this region. We come now to the

PILOT KNOB.

This is situated about seven miles south of the Iron Mountain; and obtained its name from serving as a pilot or guide to persons travelling over the country at an early period. Like the Iron Mountain it consists of an *immense mass of iron ore*, of a similar and as pure a quality. It is of a more remarkable character, being a circular cone, of about two miles in circumference at the base, and rising generally abruptly and precipitously, to a height of about 600 feet above the level of the valley. There is but little loose ore on the surface, as it is generally in masses. and has to be blasted out. There are two kinds of ore, one of which, though very rich in iron, contains so much *silex* as to render it difficult of smelting and to occasion a considerable loss, so much so that the cinder is sometimes almost as heavy as the ore. The other is a kind of "shell ore," as it is termed, and, like the "dry bone" of lead ore, much easier smelted. It requires about seventy-five pounds of limestone to five hundred of ore, and yields about fifty per cent. from the furnace. The ore is obtained from the top of the Knob, or near the summit, and has to be blasted out and beaten to pieces before "roasting." There is a little railway from the furnaces, at the foot, on the north side, by which the ore is conveyed down to them. There are two furnaces, which have been running about eight years, without making any perceptible impression on the quantity of ore! A remarkable character of this Knob is the immense masses of ore (or rather a mixture of rock and ore) by which it is surmounted, resembling in appearance, at a little distance, the ruins of some old baronial, feudal castle of Europe, with towers and turrets, partially covered with shrubs and vines. We mounted the highest pinnacle of these rocky masses, and the views on all sides were most extensive, picturesque and magnificent. It is said that there is a view of forty miles in distance in one direction!

SHEPHERD'S MOUNTAIN.

Immediately west of the Pilot Knob, and just across the valley of a creek, rises another immense mass of iron ore, called by the above name. It is of an oblong shape, about four miles in circumference at the base, and rises to the height of six hundred and thirty feet above the level of the valley, exceeding that of the Knob some thirty feet. The ore is said to lie mostly below the surface, and is as rich as that of the others, but has been little used as yet, there being no furnace dependent on it, or attached to it, and is not now used at all. This is the *third iron mountain* in this part of Missouri; but we are not yet done with them. We now come to

RUSSELL'S MOUNTAIN,

which is another one of these remarkable mountains of iron ore, lying about six miles to the southwest of the Pilot Knob; and, like the preceding ones, consists of an *immense mass of iron ore*, of the same quality. We did not have time to visit it; and can say nothing definitely as to its extent, height, &c. To the northwest of the Knob, about the same distance from it, lies

ANOTHER IRON MOUNTAIN,

the name, extent, &c., of which we did not learn any thing; only that it was of the same character with the others. There are no furnaces at either of these as we could learn.

The reader can now see why we have entitled our article, "The Iron Mountains of Missouri." And he can form some idea of the quantity and the

purity of the iron ore in this State, or rather this part of it; but perhaps only a faint idea, unless he could visit them and see for himself. Here are *five iron mountains*—not hills but mountains—of the ore; and the real quantity of pounds of iron in them, could the data be made out by which to make the computation, would be almost incalculable! We hazard the assertion that there is not such a region of iron ore in the known world. The exhausting of these vast repositories of it, placed here by an all-wise Creator for a wise and benevolent purpose, is an idea almost impossible. The whole world, for all time to come, were it made dependent on it, could hardly do it! Gold and silver are called the precious metals, but when we consider all the different and various uses to which iron is applied, it is really the precious metal. In fact, it is impossible to do without it—the world could not get along without it; and the Creator has, generally too, placed all the other facilities or materials necessary to its manufacture, as fuel, limestone, water, &c., convenient to it. And where He has placed it in such immense quantities, as here, and any of these, as fuel, for instance, may be scarce, He has made it so pure a quality as to bear the expense of transportation to points where these can be had.

The completion of the St. Louis and Iron Mountain Railroad will add greatly to the facilities of mining and disposing of the *iron* of these mountains; as the means of transportation now is by *wagons* along the plank road to Ste. Genevieve, which, although constantly crowded with wagons employed in transporting the metal and ore, affords but a slow and expensive mode of transit. The railroad is in a rapid state towards completion at the Mountain and on to the Knob, which last is the terminus, as I was informed; and appears to be nearly ready for the timbers and iron. When completed it will soon make St. Louis the greatest iron mart in the world. While on the subject of *iron* let me ask why, with such immense, inexhaustible resources of *ore*, can we not make all our own railroad iron without sending to Europe for it? From a statement I saw, some time ago in the papers, the New York Central Railroad Company were manufacturing their own iron, at a cost but little exceeding *half* of what it would cost them to procure it from Europe. And why can it not be done here in the West, and thus save the *millions of dollars* annually sent out of the country? We are not entirely independent of the "mother country," in fact, too much dependent on her for our own good.

JOURNAL OF COPPER MINING OPERATIONS.

SUPERIOR MINING COMPANY.

This, the latest incubation of the Minnesota company, has, we learn, just commenced active operations with excellent prospects of good success. We clip the following from the *L. S. Miner.*

The tract is a large one. It is a part of the original Minnesota purchase, held under a special charter, under title of Lake Superior Mining Company. The stock is divided into 3,000 shares, which were distributed *pro rata* to the holders of the Minnesota stock, at the same time the Rockland and "Location B" (now the Superior) were set off. They have 875 acres of land, of which the mineral part is more than one mile in length.

The bluff is a long and high hill, with a bold southern escarpment, and steep northern slope. It is one of the Peninsular range, lying about half a mile south of the great bluff upon which the National, Minnesota, Rockland,

Superior, and Flint Steel mines are situated, and it is directly south of the last named mine. In mineralogical character, it corresponds with the bluffs of the Forest location, on the western side of the river, and there is an apparent analogy to certain features of the Evergreen Bluff on the east. The southern range, of which it is one hill, seems to diverge somewhat from the Minnesota range in going east, as the Peninsular Bluff, at the mine of the same name, is much nearer to the National hill, than is the Lake Superior Bluff, to the Flint Steel hill.

No explorations were made upon the location before this spring. Several lines of ancient pits have been discovered, some of which have been partially cleared out. They exhibit copper in all, with occasional particles of silver. The veinstone is rather more quartzose than that of the northern bluff, but bears a most kindly and promising appearance. They have determined to open upon a vein marked by a line of ancient pits on the northern face of the bluff. The surface falls off so rapidly as to make the lode most easily accessible by an adit driven from the north, which will probably reach the vein in about one hundred feet, giving a considerable back of ground. This system of working, though it will not disclose the character of the vein quite as speedily as the mode of sinking shafts, yet it will be found more economical in the peculiar locality, as all hoisting is avoided, and the work can be prosecuted by a smaller party of men. And when once the vein is cut, it can be opened and broken to a great extent without the aid of any hoisting apparatus whatever. In works of exploration or trial, this forms a greater item of cost than the casual observer might suppose. It involves not only the cost of the animals and whim horses, with the proper winter protection, but also the breaking of winter roads, or the erection of stables, and the cost of driving and stabling the horses. And after all, the tramming is not entirely avoided, as the stuff must be taken from the mouth of the shaft to the burrows. The great advantage of an adit is generally regarded as the *drainage* which it affords. But the other considerations which we have just named, are well worthy of attention, where the surface of the ground is adapted to such an opening.

The works of the location are and will remain under the management and direction of the Minnesota Company, though it is probable that they will reorganize under another name, as soon as they are prepared to work the mine vigorously.

Other mineral indications besides those upon this vein, of the most marked and striking character, appear in the bluff, but they have not yet been examined very minutely.

The tract embraces a large extent of flat land in the immediate vicinity of the gap in the range, through which the railroad must pass if it crosses the range in this vicinity. That it will go through either the Rockland or Flint Steel gap we regard as most certain. As soon as the railroad is completed, a town of considerable importance will undoubtedly spring up near the point where it crosses the trap range, as the great bulk of winter transportation upon it will terminate there, and it will be the distributing point for mine freights brought both over the lake and over the road in summer. The present increasing population of that part of the mining district, demands a village in the vicinity. It is within about a mile and a half of the Minnesota mine, and a mile from the Rockland location.

ARIZONA COPPER MINES.

The Los Angelos *Star* states that Mr. J. J. Tomlinson, of Red Bluffs, who had taken a contract for 15 months, from June 1, to deliver 100 tons of copper ore per month, for a wealthy company in San Francisco, from their mines in the Gadsden purchase to Port Yuma, on the Colorado, a distance of some hundred miles, arrived there with seven six-mule teams in the very short space

of 14½ days from Stockton, a distance of 400 miles. The train left Red Bluffs and proceeded *via* Sacramento to Stockton, crossed the San Joaquin River 20 miles from Stockton, and travelled up the west side of the river, Tulare, Buena Vista, and Kern Lakes to Fort Tejon, having but one ferry and no toll bridges to cross the entire distance; found grass scarce, owing to the extreme dry season, but having a supply of hay and barley for feed, experienced no difficulty in arriving at the time specified, with the teams in excellent condition. Mr. Wernenger had been prospecting for some time in the Gadsden territory. As the district is attracting considerable attention, it may be stated that the distance from Fort Yuma to the Arizona Mines is 120 miles; from Arizona to Calabazas, 130 miles; Calabazas to Tueson, 70 miles; Fort Yuma to Tueson, 280 miles; Tueson to San Xaviel, 10 miles; thence to Tubac, 45 miles; and thence to Calabazas, 15 miles. Tueson is a miserable place, situate in an alkali country, and can never become a place of importance. The river sinks a mile or two below the town. Mr. Wernenger discovered, and took up for the purpose of working, a silver mine about 20 miles south-east of Tueson. In the locality fuel and water are abundant, and the ore is very rich, the alloy being copper and lead. Several specimens of the ore are almost pure silver; one piece, measuring about 5 inches and 3 inches diameter, weighs over 10 lbs. Mr. Poston is located at Laravaca Mine, which he has just opened and prepared for working; it is generally supposed to be very rich. He has purchased the Laravaca ranch, one of the best in the country. Mr. Douglass, at the Sopra ranch, is also engaged in mining, not extensively, but profitably. A large amount of very rich copper ore has been dug out of the Gadsdenian Mine, and is lying at surface, but must remain unproductive, as it is 300 miles from the Colorado River, over a road impracticable for wagons.

SAN DIEGO COPPER MINES.

The value of the newly-discovered copper mines in San Diego county continues to increase, both in value and extent. Some specimens from the Jesus Maria Mines contain from 50 to 60 per cent. of pure copper. These are considered to be much the richest mines that have yet been opened in this section. They are about 80 miles south of San Diego, on the San Antonio ranch, and within six miles of an embarcadero at the head of Encenada Bay, with an excellent natural wagon road from the mines to the embarcadero. Mr. Darnell, the proprietor of the mines, states that during the first eighteen days that he worked them he sunk a shaft, from which he has taken 25 tons of good ore. In six weeks he calculates to have 100 tons of ore ready for shipment.

ANCIENT MINING OPERATIONS AT LAKE SUPERIOR.

Col. Charles Whittlesey, of Cleveland, made some very interesting statements, respecting the ancient mining operations of Lake Superior, before the American Association for the Advancement of Science, at Montreal, last week. He said: A remarkable object in the geography of Lake Superior, is Point Kewanaw, extending out into the Lake some seventy miles, in form like the beak of an eagle. The spine of this peninsula is elevated some five or six hundred feet, and filled with copper rock, which extends beyond the limits of the point to an aggregate length of 160 miles. In very ancient periods of time mining was carried on here extensively, and excavations have been found two miles long, and from 20 to 30 feet deep. This mining was by open cuts, like quarries, for the miners had no means of penetrating deeply into the earth, nor means of raising had they so penetrated. The copper found there is well known to exist in its native form, and in masses from minute specimens to those of 500 tons. The implements and tools made by them of the metal, were constructed without melting it, by simply beating it into form in its cold state, and there are no signs whatever that they had any idea of melting copper. Their mode of mining was to build fire upon the rocks to soften

them, and then break out the pieces of metal by means of large stone hammers; masses of five or six tons are found from which pieces have been beaten, and the rest left in place.

At the Minnesota mine those miners had gone down in one place 25 feet, and recently, upon opening their excavation, a mass was found which had been raised upon skids by means of wedges, weighing six tons. The opening had been filled up by rubbish as the miners advanced, and thus, with the accumulation of centuries in addition, it was not easily perceptible. Trees of full growth covered it when again found, and the proof that this was a real excavation for mining purposes was afforded by burnt wood, stone hammers, and the like. This is a sample of those ancient works scattered along a line of 150 miles. Some few cavities have been found, in extent like a large room or hall—places where a dozen men could easily work.

The miners' tools, hammers of hard stone, 5 to 25 pounds in weight, wooden shovels of cedar, used for scraping dirt, as shown by the form to which they are worn; copper implements like the geologist's gads, to be used as cold chisels, beaten by the stone mauls; spear heads, copper knives and chisels, and the like. Upon blocks of timber are still to be seen marks of these axes or chisels.

In regard to the period when the mining operations were in progress, he said that the timber growing in the old excavations is of full size and age. He has counted 390 rings of annual growth. But this does not carry us back as far as we can go with safety. There is plenty of evidence that these ancient trees are of the second growth, at least, since the mines were deserted. This carries us back at least to six hundred years. It must, however, not be forgotten that the same species of tree does not immediately succeed when one falls, but others take its place. The miners, of course, must have cut the timber, and thus we may with confidence carry back our date to a period at least a thousand or twelve hundred years ago. Again, judging from the amount of work done, and their want of facilities, their labor must have extended through a period of five hundred years. From the fact that no remains of houses in that severe climate are found, no roads or other improvements made by permanent inhabitants, the conclusion seems inevitable that the mines were wrought only in summer, and then by some people who came thither for the purpose, and departed with the approach of winter. This people, he is of opinion, dwelt in Ohio. The mounds and the mines are of the same age. The Indians of our era could not have been the miners, nor have they any traditions whatever relating to the mines.

Another gentleman describes an ancient pit on Portage Lake, twelve to fifteen feet deep, where chisels, many stone hammers, stones used for sharpening gads, a skid, charred by fire, &c., were found. In this pit a tree, with four hundred annual circles, was growing. He concurred fully in Col. W.'s conclusions

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JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

LEAD MINES OF ILLINOIS.

The Galena *Courier* contains the following in relation to the lead mines near that city:

The impression prevails abroad very generally that the lead mines in this region are about exhausted, that the old leads have been worked out, and that no new ones are discovered. While it is true that not as much mineral has been raised since 1849 as there was for the same number of years preceding it, this is not owing to any failure of the mineral. The Mexican war

and the California gold mines drained the lead region of a large proportion of its most enterprising and successful miners. The present miners are mostly Cornish men, who work very faithfully on leads that have been opened, but are averse to prospecting, and make but few discoveries. Farming has paid much better of late years than formerly, has produced more certain returns than mining, and consequently many have abandoned the mines and turned their attention to cultivating the soil. The prices for labor for the farms and workshops are much better than a few years ago. A great deal of land, which formerly was opened to prospectors, has since been inclosed and is now cultivated. The field for prospecting is therefore more restricted than formerly. For these reasons there is little prospecting compared with former years, and consequently not so much mineral is obtained. But there is no failure of the mineral, and taking the number of men engaged in it, mining was never more prosperous than at present, never yielded larger returns, and the miners were never doing better. The most extensive diggings which are worked at present are owned by two brothers by the name of Mills, and are located near Hazel Green, nine miles from this place. The lead was discovered about two years ago, and has yielded thus far over two million pounds of mineral. About 40,000 pounds a week are now being got out. The fortunate proprietors, after taking out nearly $100,000 worth of mineral, were offered, a short time ago, $60,000 for their "show," but refused it. The other leads in the vicinity of Hazel Green are doing well. The Marsden lead, near the city, owned by Messrs. Marsden & Hughlett, is yielding a rich harvest to its proprietors. A short time ago some 57,000 pounds of mineral were got out in one week, and the average yield per week is about 20,000 pounds. The mines at Elizabeth, Shullsburg and Fairplay, are all doing well.

SILVER ORES FROM THE GADSDEN PURCHASE.

The Sonora Exploring & Mining Co., of Cincinnati, have received a small shipment of the mines now opened by its agents. The following are the analyses, as made by the gentlemen whose names are attached to them:

	Silver in the pound Avoirdupois.
Prof. Jas. C. Booth, of the United States Mint at Philadelphia	$0.67 1-10
Do	0.23 3-4
Prof. John Torrey, of the U. S. Assay Office, New York	$0 16. 14-100
Prof. John M. Locke, of Cincinnati	0.20 1-5
Edward Kinsey, Manufacturing Jeweller, of Cincinnati	0.61 1-8
Do	1.34

The average of the above yield is a fraction over 58 cents of silver to the lb. avoirdupois of ore.—*R. R. Record.*

MISCELLANIES.

CRYSTALLIZED BORON.

Wohler and Deville have prepared boron in a crystallized form by melting boracic acid, mixed with 80 per cent. of aluminum, in a carbon crucible, inclosed in one of black lead, and heating it for five hours. When cool the crucible is broken, and the fused mass which it contains is found to consist of two layers—one vitreous, and composed of alumina and boracic acid; the other vesicular, iron gray, and containing small crystals of boron. The metallic-looking layer, which is composed of aluminum, impregnated with boron, is boiled with a concentrated solution of caustic soda to separate the aluminum. It is then treated with boiling hydrofluoric acid to remove iron; and, lastly, it

is digested with nitro-hydrochloric acid, to dissolve out any traces of silicum which might remain after the treatment with caustic soda. Boron prepared in this manner almost invariably contains laminæ, which must be removed mechanically, as they cannot be dissolved chemically. Crystallized boron obtained by the foregoing method is transparent, and of a garnet red, or frequently honey-yellow color. The color the authors believe to be adventitious. In their lustre and refractive power, the crystals resemble the diamond; the thicker crystals have a metallic appearance. Crystallized boron scratches corundum. A polished sapphire, rubbed with boron powder, was scratched on the surface, and the edges were worn down. A polished diamond, with which some boron crystals were crushed upon a crystal of quartz, was slightly scratched at all the points of contact. Boron may, therefore, be considered as the hardest substance with which we are at present acquainted. The crystalline form of boron could not be determined, for though large crystals were obtained, they were found to consist of regular aggregations of several small ones. Crystallized boron is not melted by means of the oxy-hydrogen blow-pipe; it resists the action of oxygen even at high temperatures, but at the temperature at which a diamond burns the surface becomes coated with a film of boracic acid, which protects it from further oxidation. Chlorine readily acts upon boron, and when heated in an atmosphere of this gas it takes fire, and is converted into gaseous chloride of boron. Boron, when heated between two pieces of platinum foil, causes the metal to fuse immediately, due to the formation of a boride of platinum. None of the acids, separately or mixed, hot or cold, act upon boron. At a bright red heat bisulphate of potash converts it into boracic acid, sulphurous acid being at the same time evolved. A boiling solution of caustic potash does not attack boron, but when it is heated to redness, either with hydrate or carbonate of soda, it is slowly dissolved. Nitrate of potash at a red heat does not appear to have any action upon boron.

GEOLOGICAL SURVEY OF THE BRITISH ISLES. MUSEUM OF PRACTICAL GEOLOGY, SCHOOL OF MINES AND MINING RECORD OFFICE, JERMYN STREET.

Of the £73,855 to be voted this year for the Science and Art Department, the sum of £14,548 is required for the Institution in Jermyn-street, which includes the Geological surveys of England, Ireland, and Scotland, with the attached School of Mines, Museum of Practical Geology, and Mining Record Office.

The sum of £14,548 is appropriated as follows:—

For the Geological Survey of England and Scotland	£5606 11 0
For the Geological Survey of Ireland	2743 9 0
Salaries of the director and seven lecturers or professors of the School of Mines	1600 0 0
Mining Record office, including the salaries of the keeper, his assistant, travelling expenses, &c.	782 10 0
Museum, Library, &c., including the salaries of officers and servants	3815 10 0
Total	£14,548 0 0

When it is considered that this is the only public scientific establishment for the development of the mineral structure of the country, the produce of which exceeds *thirty millions* per annum; that the sale of the geological maps and sections is very considerable (exceeding 4000 last year), and that the Mining Record Office, besides furnishing an annual volume of mineral statistics, has supplied the House of Commons with Returns nowhere else to be obtained, it will be admitted that the estimate for this useful branch of the public service is moderate.—*London Mining Journal.*

SAND FOR GLASS-MAKING.

We were shown a specimen of white sand, which for purity excels any perhaps that has ever been discovered in Missouri. In appearance it closely

resembles the best refined sugar, is easily pulverized, and though not yet submitted to a thorough chemical analysis, is evidently free from oxide of iron, or any other substance that would tend to unfit it for manufacturing purposes. If there is any foreign substance at all present it is probably lime, which is a harmless, if not necessary, element in glass-making. This sand, we understand, is found in abundant quantity in the locality mentioned, and near the quarry is a deposit of *kaolin*, another item of the unequalled mineral and geological wealth of Missouri.

WELL BORING ON DESERTS.

The experiment of boring for water on the Great Desert of Sahara, in Asia, has recently been crowned with success. The *St. Louis Leader* gives, from the correspondence of a French paper, the following description of the scene which followed the overflow of the water. The point selected for boring was an oasis, nearly parched up by the hot, dry season. After boring to the depth of one hundred and seventy-seven feet—a very shallow depth—the water gushed forth in a stream estimated to average a thousand gallons per minute. The astonishment and delight of the Arabs are thus depicted by the writer:

"At the moment of the water's bursting forth no Arab was present, but the news quickly spread, and in a few minutes the whole population of the village rushed to the spot, and threw themselves upon the works with such frenzy that force was necessary to remove them. Women and children lay down in the stream, as if they had never seen water before. The old Sheik of Sidi Rached could not repress his emotion; he threw himself on his knees by the trough and wept for joy. The next day the inhabitants of the neighboring Arab villages came to thank the engineer and to bless the fountain, while in the evening there was a dance and grand merry-making, and this festival was kept up for six days. In the mean time, the people went immediately to work and constructed a sluice, to convey the vivifying stream to the portion of the oasis which was dead for want of moisture."

The experiments of the past year on the deserts along the Southern Emigrant route between the Atlantic and Pacific, together with the one above recorded on the Great Desert of Sahara, afford abundant evidences of the possibility of procuring water in other similiar localities. We notice that preparations have been made, and expeditions are no doubt now on the ground with proper implements, &c., for continuing these explorations during the present season.

MINER'S SAFETY LAMP.

We have inspected a very superior description of safety-lamp, the invention of Mr. J. J. Mozard, of Dufour's place, Golden-square, the chief features in which consist in the wick-tube being so connected with the bolt of the lock by which the lamp is kept closed, that it is impossible to move the bolt, with a view to open the lamp, without extinguishing the light—the wick and wick-tube being drawn entirely within the oil chamber: and a chimney being provided within the gauze, so that the flame cannot be blown or drawn through. Mr. Mozard, in specifying his patent, explains that the upper parts of the lamp are screwed on to the lower part, or oil vessel, in such a manner that the parts cannot be unscrewed without acting on the wick of the lamp, and drawing it into the wick-tube, so as to extinguish the flame: hence a man using such a lamp cannot obtain a light by opening the lamp. To accomplish this object, there is a trigger, or lever, which is acted on several times by projections, or catches, in the act of unscrewing the parts. This trigger, or lever, gives motion to a claw, which each time it is moved enters the wick, and

causes it to be drawn down a distance into the wick-tube, and the wick is prevented from rising by its elasticity, or otherwise, by spring points, which retain the wick down to the position it may be brought by the claw. In order to prevent the flame being blown or drawn through the wire gauze, a chimney is used, which ascends to such a height as to prevent the flame being acted on. The wire gauze is closed at top, and also at the bottom, except where the chimney passes into it. Above the upper part of the oil vessel, and below the wire gauze, the flame is protected by a cylinder of thick glass. The wick is snuffed by the ordinary bent wire. In a miner's lamp arranged according to this invention, the gauze shade and parts connected therewith cannot be removed from the lamp without drawing the wick into the wick-tube, and extinguishing the flame; there is an oil vessel, on the top of which is formed the screw for receiving the ring to which the shade of the lamp is attached. A spring catch, or trigger, projects up through a slot in the top of the oil vessel, and is curved at the end of the wire, which slides through a hole in the support, and has coiled round it the spiral spring. The end of the wire is bent up, and acts on the arm at the end of the axis, which is supported by projections, from the top of the oil vessel, and has coiled round its further end the spring. There is a claw fixed on the axis, acting so as to draw the wick into the wick-tube when the ring is unscrewed. The snuffing wire is of the ordinary kind. The action of the apparatus is, on the under side of the ring are three or more projections, which, when the ring is screwed on, pass over the catch; for the inclined sides of the said projections come in contact with the inclined side of the catch, so as to press it down, and it is permitted to descend by the yielding of the supporting spring; but when the ring is unscrewed, the straight sides of the projections come in contact with the straight side of the catch, which is thus drawn forward until its inclined end comes in contact with the end of the slot, and during this motion the end of the wire acts on the arm of the axis, which is thus caused to make a partial revolution, and the claw enters the wick, and draws it partially and completely into the wick-tube. As the unscrewing of the ring is continued the catch descends, and is then brought back by the spring to its starting point; at the same time the claw is brought back by the spring, and to the wick rising with the claw spring points may be used, but this the inventor does not find essential in practice. When by further unscrewing the ring another projection is brought up to the catch, the operation is repeated, and so on until the light is extinguished. In a modification of the invention, the lamp is also arranged so that the gauze shade and the parts connected therewith cannot be unscrewed without drawing the wick into the wick-tube, and extinguishing the flame; but it differs somewhat in its details from the lamp already described. The oil vessel is formed for receiving the ring, as before; but there is also a horizontal axis supported at one end by the projection from the bottom of the oil vessel, and passing out through the side of the oil vessel through a piece of leather, to make a tight joint. On the end of the axis a short tube is fixed, into which the stem of the key just fits, and the side of this tube is notched to receive the projecting part of the key: this key acts to depress the spring catch, and until this catch is depressed by turning the key the ring cannot be unscrewed, for it has projections on its under side, as in the lamp already described; but by turning the key to depress the catch, motion is given to the axis, and so to the claw, which draws the wick into the wick-tube, and extinguishes the light. The inventor claims, first, the so arranging a miner's lamp that the gauze shade cannot be removed without extinguishing the flame: and, second, the arrangement of the metal chimney, and the cylinder of wire gauze closed at the top and bottom, as described. The lamp, which is stated to give the light of six candles, can be supplied for about 10s.; and with a view to promote the adoption of a means of lessening the loss of life from causes which would be prevented by the use of an efficient safety-lamp, we shall have a model lamp at our office, for the inspection of those interested, and will undertake to receive orders from those desirous of adopting the invention.—*London Mining Journal.*

The Mineral Resources of Southern Illinois is exciting considerable interest in certain quarters, from the discoveries made in the survey of the route for the Southern Illinois railroad from Mound City to Grayville. Veins of brown hematite iron ore were found from ten to fifteen feet in thickness, that could be drifted without stripping, and could be delivered at a tunnel head of a furnace at a cost of $1 per ton for the ore. The whole region is underlaid with strata of coal, which have been penetrated at different points and found to be four and five in number, lying in convenient positions, one upon another, so that all can be worked together, by a single shaft. Indications of salt water—like that found at Equality—for the manufacture, were observed at several points. A fine chalybeate spring was discovered in one location gushing from the side of the hill, which had failed to attract any notice from the inhabitants of the entire neighborhood, except that its waters were so bad that the cattle would not drink it in the driest times. Signs of lead were observed among the hills in different places, and the finest quarries of free and limestone, presented themselves at numerous points along the line. With these rich mineral resources, the greater portion of the district is as fertile as any other portion of the rich estate of Illinois.

But a most interesting fact has been communicated by a gentleman who had been making some geological examinations of the district, who employed one of the natives to gather for him specimens of the various curious rocks and minerals found in a region of country around Elizabethtown.

The specimens were packed in a box, and transported a long distance to the gentleman's home. On opening the box and removing its contents, a large globule of quicksilver was observed on the bottom; curious to know where it could have come from, he began an investigation to account for its presence. Finding no other satisfactory explanation, he began to examine the rock with a powerful microscope, and in one of the specimens, to his surprise, he discovered particles of quicksilver in its pores. He sent the rock to Professor Owen, who, on examination, pronounced it a rich specimen of *cinnabar* from which quicksilver is obtained. These specimens were gathered up promiscuously by an illiterate man, who picked up only such as were uncommon in their external appearance. In what particular location he found the cinnabar, he is unable to tell himself, and as he traced a pretty wide district, he has left a wide field for search to learn if there be more. The inference is, there is more of it, and perhaps a valuable vein.—*Evansville, Ind., Daily Journal.*

VENTILATION OF COLLIERIES.

Mr. W. Hopton, of Carlton, near Wakefield, has forwarded to us a plan for the better ventilation of coal mines. This is well illustrated with a section of the workings at Lund Hill, previous to the latter dreadful explosion. One of his propositions is, there should be separate wind-courses in every part, so that if the gas should explode in one set it will be almost exclusively confined to that particular portion, and have but little effect elsewhere, inasmuch as each set of miners has its own wind fresh from the downcast, although by this, if the mine were divided into twelve sets, each would only receive a twelfth part of the air, yet only one twenty-fourth of the gas would be allowed to enter the working part; not as is at present the case, where the greater portion of the gas from the goaves and return air-gates is allowed to enter the workings. The number of doors, he observes, are too numerous. He recommends—1. That at the top of each shaft there should be sufficient room for the air to ascend and descend in the mine.—2. That the shafts be large enough, and free from waterfalls.—3. To have two furnaces.—4. The air-gates to be of sufficient area.—5. Never to have more works than can be ventilated with safety.—6. Every stopping to be made of bricks and lime.—7. Examine every set or air-course with an anemometer.—8. That every set be separately winded in a pit. It will be seen that the above suggestions are eminently practical.

MINING MAGAZINE.

EDITED BY

WILLIAM J. TENNEY.

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VOL. IX.—NOVEMBER, 1857.—No. V.

Art. I.—THE PRACTICAL MINER'S GUIDE. By J. Budge. No. 9.

(Continued from page 305, Vol. IX.)

TO FIND THE CUBIC FEET.

Inches in a cubic foot—1728) 8134·0272 Inches as before.

4·7124 Cubic feet.

TO FIND THE POUNDS.

4·7124 Cubic feet as before.
1000 oz. weight of a cubic foot of water.

16) 4712·4000

294·525 lbs. weight.

A Table showing the weight, wine gallons, and cubic feet of water contained in six feet of pump from four to twenty inches in diameter.

Diameter of Pump.	Weight.	Wine Measure.			Cubic Feet.	Diameter of Pump.	Weight.	Wine Measure.			Cubic Feet.
ins.	lbs. dec.	gal.	qts.	pts.	ft. dec.	ins.	lbs. dec.	gal.	qts.	pts.	ft. dec.
4	32·75	3	3	1	·522	12¼	306·95	36	2	1	4·910
4¼	36·95	4	1	1	·591	12½	319·60	38	1	0	5·113
4½	41·42	4	3	1½	·662	12¾	332·51	39	2	1	5·319
4¾	46·15	5	2	0	·738	13	345·68	41	1	1	5·530
5	51·14	6	0	1	·818	13¼	359·10	42	3	1	5·745
5¼	56·38	6	3	0	·902	13½	372·78	44	2	1	5·960
5½	61·87	7	1	1¼	·989	13¾	386·72	46	0	1	6·187
5¾	67·63	8	0	0¾	1·082	14	400·90	48	0	0	6·414
6	73·63	8	3	0	1·178	14¼	415·35	49	2	1	6·645
6¼	79·90	9	2	0	1·278	14½	430·00	51	1	1	6·880
6½	86·42	10	1	0	1·382	14¾	44[illegible].00	53	0	1	7·119
6¾	93·20	11	0	0	1·491	15	460·23	55	0	1	7·363
7	100·22	12	0	0	1·603	15¼	475·69	56	3	1	7.610
7¼	107·51	12	3	0	1·720	15½	491.42	58	3	0	7·862
7½	115·00	13	3	0	1·840	15¾	507·40	60	2	1	8·117
7¾	122·85	14	2	1	1·965	16	523·63	62	2	1	8·379
8	130·90	15	2	1	2·094	16¼	540.13	64	2	1	8·641
8¼	139·22	16	2	1	2·227	16½	556·87	66	2	1	8·909
8½	147·78	17	2	1	2·354	16¾	573·88	68	2	1	9·181
8¾	156·60	18	2	1	2·505	17	591·13	70	3	0	9·457
9	165·68	19	3	0	2·650	17¼	608·65	72	3	0	9·739
9¼	175·00	20	3	1	2·800	17½	626·42	75	0	0	10·022
9½	184·60	22	0	0	2·953	17¾	644·67	77	0	1	10·310
9¾	194·45	23	1	0	3·110	18	662·73	79	1	0	10·602
10	204·54	24	1	1	3·272	18¼	681·26	81	2	0	10·899
10¼	214·90	25	2	1	3·438	18½	700·00	83	3	0	11·142
10½	225·51	27	0	0	8·607	18¾	719·10	86	0	1	11·504
10¾	236·37	28	1	0	3·781	19	738·40	88	1	1	11·813
11	247·50	29	2	1	3·959	19¼	757·96	90	3	0	12·126
11¼	258·87	30	3	1	4·141	19½	777·78	93	0	1	12·443
11½	270·51	32	1	1	4·827	19¾	797·85	95	2	0	12.764
11¾	280·40	33	2	1	4·518	20	818·18	97	3	1	18·090
12	294·53	35	1	0	4·712						

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Horse-power, Load in Pounds, and Speed per Minute of Cornish "Single Acting" Expansive Steam Pumping Engines, having Cylinders from 15 *inches to* 100 *inches diameter. Initial Pressure of Steam,* 30 *lbs. per Square Inch. Temperature* 251·6°. *Full Pressure of Steam* ½ *of stroke. Mean Pressure of Steam* 17·8 *lbs. less* 1·5th *friction* = 14·24 *lbs.*

Diameter of Cylinder.	Length of Stroke in Cylinder.	Area of Cylinder.	Load in pounds, less 1·5th, for Friction.	Strokes per Minute.		Speed per Minute in Feet.		Horse Power.		Effective Horse Power per Stroke.
				Economical Working.	Safe Working.	Economical Working.	Safe Working.	Economical Working.	Safe Working.	
Ins.	Feet.	Inches.	Pounds.			Feet.	Feet.	Horses.	Horses.	Horses.
15	8	176·71	2,516	5	14	80	224	3·04	8·53	·609
16	8	201·06	2,863	5	14	80	224	3·47	9 71	·694
17	8	226·98	3,232	5	14	80	224	3·91	10 96	·723
18	8	254·46	3,623	5	14	80	224	4·39	12 29	·878
19	8	283·52	4,037	5	14	80	224	4·89	18 70	·978
20	9	314·16	4.473	4½	12	81	216	5 48	14·63	1·219
21	9	346·36	4,932	4½	12	81	216	6.05	16·14	1 345
22	9	380·13	5,413	4½	12	81	216	6·62	17·71	1·476
23	9	415·47	5,916	4½	12	81	216	7·26	19·36	1·613
24	9	452·39	6,442	4½	12	81	216	7·90	21·08	1 756
25	9·5	490·87	6.989	4½	10½	85½	200	9·05	21·17	2·012
26	9·5	·530·93	7,560	4½	10½	85½	200	9·79	22·90	2·176
27	9·5	572·55	8,153	4½	10½	85½	200	10·56	24·70	2 347
28	9·5	615·75	8,768·	4½	10½	85½	200	11·35	26 57	2·524
29	9·5	660·52	9,405	4½	10½	85½	200	12·18	28·50	2·707
30	10	706·86	10,065	4	10	80	200	12·20	30·50	3·050
31	10	754·76	10,747	4	10	80	200	13·02	32·56	3·256
32	10	804·24	11,452	4	10	80	200	13·88	34·70	3·470
33	10	855·30	12,179	4	10	80	200	14·76	36·90	3·690
34	10	907·92	12,928	4	10	80	200	15·67	39·17	3·917
35	10	962·11	13,700	4	10	80	200	16·60	41·51	4·151
36	10	1017·8	14,492	4	10	80	200	17·56	43·91	4·391
37	10	1075·2	15,310	4	10	80	200	18·55	46·39	4·639
38	10	1134·1	16,148	4	10	80	200	19·57	48·93	4·893
39	10	1194·5	17,009	4	10	80	200	20·61	51·54	5·154
40	10	1256·5	17,894	4	10	80	200	21·68	54·22	5·422
41	10	1320·2	18,799	4	10	80	200	22·78	56·96	5·696
42	10	1385·4	19,728	4	10	80	200	23·91	59 78	5·978
43	10	1452·2	20,679	4	10	80	200	25·06	62·66	6·266
44	10	1520·5	21,652	4	10	80	200	26·24	65·61	6·561
45	10	1590·4	22,647	4	10	80	200	27·45	68·62	6·862
46	10	1661·9	23,664	4	10	80	200	28·68	71·71	7·171
47	10	1734·9	24,705	4	10	80	200	29 94	74·86	7·486
48	10	1809·5	25,768	4	10	80	200	31·23	78·08	7·808
49	10	1885·7	26,852	4	10	80	200	32·54	81 37	8·137
50	10	1963·5	27,956	4	10	80	200	33·88	84·71	8·471
51	10	2042·8	29,089	4	10	80	200	35·25	88·14	8·814
52	10	2123·7	30,240	4	10	80	200	36 65	91·63	9·163
53	10	2206·1	31,414	4	10	80	200	38·07	95·19	9·519
54	10	2290·2	32,612	4	10	80	200	39·52	98·82	9·882
55	10	2375·8	33,831	4	10	80	200	41·00	102 51	10·251
56	10	2463·0	35,072	4	10	80	200	42·50	106·27	10·627
57	10	2551·7	36,336	4	10	80	200	44·04	110·10	11·010
58	10	2642·0	37,620	4	10	80	200	45·60	114·00	11·400
59	10	2733·9	38,930	4	10	80	200	47·18	117·97	11·797
60	10·5	2827·4	40,260	4	9½	84	200	51·24	122 00	12·810
61	10 5	2922·4	41,614	4	9½	84	200	52·96	126·10	13 240
62	10·5	3019·0	42,988	4	9½	84	200	54·71	130 26	13·678
63	10·5	3117·2	44,388	4	9½	84	200	56·49	134·50	14·123

Horse power, Load in Pounds, and Speed per Minute of Cornish "Single Acting" Expansive Steam Pumping Engines, having Cylinders from 15 *inches to* 100 *inches diameter. Initial Pressure of Steam,* 30 *lbs. per Square Inch. Temperature* 251·6°. *Full Pressure of Steam* ½ *of stroke.—Mean Pressure of Steam* 17·8 *lbs. less* 1-5*th friction*=14·24 *lbs.*

Diameter of Cylinder.	Length of Stroke in Cylinder.	Area of Cylinder.	Load in pounds, less 1-5th, for Friction.	Strokes per Mintue.		Speed per Minute in Feet.		Horse Power.		Effective Horse Power per Stroke.
				Economical. Working.	Safe Working.	Economical Working.	Safe Working.	Economical. Working.	Safe Working.	
Ins.	Feet.	Inches.	Pounds.			Feet.	Feet.	Horses.	Horses.	Horses.
64	10.5	3216.9	45,808	4	9½	84	200	58·30	138·81	14·575
65	10.5	3318.3	47.258	4	9½	84	200	60·13	143·18	15·034
66	10.5	3421.2	48.716	4	9½	84	200	62·00	147·62	15·500
67	10.5	3525.6	50 204	4	9½	84	200	63·89	152·13	15·974
68	10.5	3631.6	51,712	4	9½	84	200	65·81	156 70	16·453
69	10.5	3739 2	53,246	4	9½	84	200	67·76	161·35	16·941
70	11	2848.4	54,800	4	9	88	198	73·06	164·40	18·266
71	11	3959.2	56,379	4	9	88	198	75·17	169·13	18·793
72	11	4071.5	57,978	4	9	88	198	77·30	173·93	19·326
73	11	4185.3	59,593	4	9	88	198	79·46	178·79	19 866
74	11	4300.8	61,240	4	9	88	198	81·65	183·72	20·413
75	11	4417.8	62,909	4	9	88	198	83·87	188 72	20 969
76	11	4536.4	64,592	4	9	88	198	86 12	193·77	21·530
77	11	4656.6	66,310	4	9	88	198	88·41	198·93	22 103
78	11	4778.3	68 036	4	9	88	198	90·71	204·10	22·670
79	11	4901.6	69,798	4	9	88	198	93·06	209·39	23·266
80	11 5	5026.5	71,578	4	8½	92	196	99·77	212·56	24·943
81	11.5	5153.0	73,378	4	8½	92	196	102·28	217·91	25,571
82	11.5	5281.0	75 201	4	8½	92	196	104·82	223·32	26·206
83	11.5	5410.6	77,046	4	8½	92	196	107·39	228 80	26·849
84	11.5	5541.7	78,913	4	8½	92	196	110·00	234·04	27·499
85	12	5674.5	80,804	4	8	96	192	117·53	235·06	29·383
86	12	5808.8	82,717	4	8	96	192	120·31	240·63	30·078
87	12	5944.6	84,651	4	8	96	192	123·12	246·25	30·782
88	12	6082.1	86,609	4	8	96	192	125·97	251·95	31·494
89	12	6221.1	88,588	4	8	96	192	128·85	257·71	32·213
90	12	6361.7	90,590	4	8	96	192	131·76	263·53	32·941
91	12	6503.8	92,614	4	8	96	192	134·71	269·42	33·677
92	12	6647.6	94,661	4	8	96	192	137·68	275·37	34·422
93	12	6792.9	96,730	4	8	96	192	140·69	281·39	35 174
94	12	6939.7	98,821	4	8	96	192	143·73	287·47	35·935
95	12	7088.2	100,925	4	8	96	192	146·80	293·60	36·700
96	12	7238.2	103,071	4	8	96	192	149·92	299·84	37·480
97	12	7389.8	105,230	4	8	96	192	153·06	306·12	38·265
98	12	7512.9	107,410	4	8	96	192	156·23	312·46	39·058
99	12	7697.7	109.615	4	8	96	192	159·44	318·88	39·860
100	12	7854 0	111,840	4	8	96	192	162·67	325·35	40·669

The above table has been compiled with the object of furnishing an approximate value of the Power in Horses rendered by Cornish Pumping Engines having Cylinders from Fifteen to one huudred inches diameter. The elements employed for the calculations are those most usual with Cornish engineers; and the effective Horse-power per stroke is given, that the enquirer may ascertain the total value of Horse-power resulting from working any given number of strokes per minute. The

Steam in most of the Cornish Pumping Engines, is only permitted to act on one side of the Piston; hence such mode of working is technically termed "single acting." Recently, however, it has been considered that equal economy is obtained by introducing the steam on both sides of the Piston, and a few Engines are in operation on this principle. The Horse-power of such (double-acting) engines may be found by doubling the results given in the Table.

A TREATISE ON THE QUALITY, MANUFACTURE, AND CHOICE OF CORDAGE, FOR MINING PURPOSES, WITH RULES AND TABLES FOR THE WEIGHT AND NUMBER OF THREADS CONTAINED IN ANY SIZE ROPE.

It is certainly very desirable, if not absolutely necessary, that every person who is intrusted with the management of a mine should possess some means of obtaining, with a degree of certainty, the quality and weight of the ropes he may have occasion to use; otherwise the lives and property intrusted to his care will be continually placed in jeopardy, and his employers be always subject to impositions respecting the charge; because in many cases (from the magnitude of the material) it cannot be weighed, and therefore its weight can only be ascertained by computation; consequently, if the agent is ignorant of the matter, the right of the adventurers will solely depend on the truth of the manufacturer's calculation.

The following tables will enable the agent to find the weight of any rope, and the ensuing remarks will help his judgment respecting the quality thereof; being far the most important part of the subject.

There are various methods of discovering the quality of hemp; but as miners have seldom an opportunity of inspecting the article in this stage of preparation, we shall pass on, and show how it may be proved after its having been completely manufactured.

The first thing that commands our particular attention is, the size of the yarn or thread of which the rope is composed. There is a certain gauge or standard for this, known among ropemakers by the terms, sixteens, eighteens, twenties, &c., which means 16, 18, or 20 yarns in the strand, or third part of a rope 3 inches in circumference. The following table shows the weight of the different sizes of yarn before it has gone through the operation of tarring.

Size.	Length.	Weight lbs.	Weight oz.
25	170 fathoms.	2	13
20		3	8
18		3	15
16		4	6
15		4	10

Now the true standard size for shroud-laid rope is *twenties**, and it is of consequence that agents should give their orders accordingly, and afterwards be assured that their ropes have really been made with yarns of this gauge.

In order to prove this, first, girt the circumference of the rope, then count the yarns in the strand, and, lastly, refer to the table (page 403) and note if the number corresponds with that standing in the proper column, opposite the dimensions of the rope.

Manufacturers have many inducements for spinning their yarn large. First, it is less expensive, for it requires no more time to spin a large yarn than to spin a small one, and 16 or 17 yarns (in their way) will answer the end of twenty. Secondly, in large yarns, inferior or refuse hemp can be spun, which cannot be done in yarns of a smaller size; and this consideration, if there was no other, should cause the agent to be exceedingly particular in having his rope made of standard yarns; and let it be remarked, that although a rope made of sixteens or eighteens will be nearly equal in weight to another made of twenties, yet by no means will it be equal in strength, even if made of the very same kind, or indeed of superior hemp. This is too plain a truth to need any illustration: for though it may be argued that what is wanting in number is made up in bulk, yet it will support an equal weight no more, in proportion, than a body of raw hemp the size of a cable will be as strong as the cable itself.

By inspecting the table (page 403) it will be seen that the strand of a 16-inch capstan-rope made of twenties contains 569 yarns, but if made of sixteens, only 455 yarns; making a difference in the whole rope of 342 yarns.

We shall now give a plain and expeditious, though infallible, method, of proving the quality of hemp and yarn, viz. from the end, or *fag*, of the rope cut several of the yarns in fathom lengths, each of these (standard size) should suspend, or bear up separately, 70 pounds weight at the least.

Regard must next be paid to the last part of the manufacture, called the *lay*, or twist, of the rope; and this should undergo a strict examination, as much depends on the skill and attention of the manufacturer in this part of the process; for it is very possible that the best materials may be used, the yarn spun of the proper size, and with the greatest care, and yet the rope be very defective, and by no means fit to be depended on. This may be easily discovered when the rope is laid in a straight line; then, if either of the strands is observed to mount or fall†, that is, rise

* Of which it is shown in the preceding table that 170 fathoms weigh only 8 lbs. 8 oz. or 3½lbs.

† This fault or defect is known among ropemakers by the term "pinch," and as the remedy occasions a great deal of trouble and delay, it is too often suffered to pass, especially as few persons are able to detect it, or are aware of its injurious tendency.

There are many casual occurrences whereby ropes are exposed to injuries

above or sink beneath the others, in any degree, the rope has been *crippled*, or inevitably spoiled; for if the former case, of one strand rising, in the event of trial, that strand will be found to bear little or none of the weight, when the other two will break; and in the latter case, of one strand sinking, that strand will break before the other two have been brought to the strain, or have borne any considerable part of the weight.

These great defects in cordage are too often to be found, and almost as often pass unobserved; but they may always be detected by a close inspection, and thereby many of the serious injuries and fatal accidents which so often take place in mining, be happily prevented.

We shall close these observations after remarking, that as nearly all cordage used in mining is much exposed to the alternate influence of sun and moisture, which tends greatly to accelerate its decay, it ought by all means to contain a greater quantity of tar than is generally used. The common rule is 1 to $5\frac{1}{4}$, or 1 to 6; but the proportion of 1 to $4\frac{1}{2}$, or 1 to 5, would be much better: but we recommend this increase for standing ropes only, such as capstan-ropes, &c.; as from the comparative unfrequency of their use, and the length of time they endure, are equally liable to injury from mould and decay, as from strain and friction.

The common practice of tarring the surface of the rope after it has been manufactured is of very little service: the way we recommend is, by reducing the ordinary weight suspended to the lever, during the process of tarring the yarn in the manufactory, when it is drawn in a body from the heated coppers through the knipper, whereby the tar being lodged in the internal part of the rope cannot fail of preserving it under all circumstances.

The following rules, examples, and tables will be found plain, convenient and correct.

TO FIND THE NUMBER OF THREADS IN A SHROUD-LAID* ROPE.

Rule.—State the question as in direct proportion, square the first and third terms, multiply the second and third terms together, and divide the product by the first.

in mines, out of the common course of working. We may notice an instance or two, viz. inattention or ignorance in taking them from the coil when new; they should always be taken out the contrary way from which they were coiled in: that is, if a capstan rope is coiled into a wagon, the uppermost end should be put down and drawn from the under part of the carriage: also, in small cordage, the inward extremity of the rope should be taken and drawn through the aperture of the reel. The general disproportion of capstan gear in mines has a most destructive effect on the ropes; the sheaves or *pulleys*, as well as the *barrel*, of the capstan being considerably too small; indeed there is still room for much improvement in this part of mining machinery.

* The term "shroud-laid" is used to distinguish a rope of three strands or parts from another of nine strands, which is termed "cable-laid." The latter

EXAMPLE.

How many standard yarns, or threads, are there in a 14-inch capstan rope?

```
     in.  yarns.   in.
  As 3  :  20  ::  14
     3             14
     —             —
     9             56
                  14
                  ——
                  196
                   20
                  ——
              9) 3920
                 ————
      Answer 435 threads in the strand.
               3
             ————
          or 1305 threads in the rope.
```

EXAMPLE.

How many standard yarns are there in a $9\frac{1}{2}$ inch rope?

```
     in   yarns.   in.
  As 3  :  20  ::  9·5
     3             9·5
     —             ———
     9             475
                  855
                  ————
                  90·25
                     20
                ————————
             9) 1805·00
                ————————
   Answer       200· threads in the strand.
                  3
                ————
                600 threads in the rope.
```

TO FIND THE WEIGHT OF SHROUD-LAID ROPES.

Rule.—State the question and square the numbers as in the last example.

EXAMPLE.

If 1 cwt. of 3-inch rope measures 54 fathoms*, what will be the length of an cwt. of a 12-inch rope.

```
     in.        fath.         in.
  As 3    :      54     ::    12
     3            9           12
     —          ———           ———
     9    144) 486 (3·375     144
               432     6
               ———   —————
               540   2·250
               432      12
               ———   —————
              1080   3·000
              1008
              ————
               720
               720
               ———

                        fath. ft. in.
                 Answer   3    2   3
```

may be said to be 3 shroud-laid ropes twisted together. It is seldom that any other but three-strand ropes are used in mines.

The length of standard yarn to a lb. is 48 fath. 2 ft. 4·3 in. after it has been tarred, and 54 fathoms of 3-inch rope are exactly 1 cwt. By this rule the following tables have been constructed. It must be recollected that this computation is made, estimating the proportion of tar 1 to $5\frac{1}{2}$ only.

EXAMPLE.

If 100 fathoms of 3-inch rope weighs 1 cwt. 3 qrs. 11·3 lbs., what will be the weight of a 15-inch rope the same length?

```
   in.  cwt. qrs. lbs.
As 3  :  1   3   11·3  : :  15
   3     4                  15
   -     -                  --
   9     7                  75
        28                  15
       ----                ---
      207·3                225
        225
     -------
  9) 46642·5
     -------
112)  5182  (46
      448
      ---
      702
      672
      ---
       30
      ---
```

cwt. qr. lbs.
Answer 46 1 2

TO FIND THE WEIGHT OF ROPES BEING 120 FATHOMS IN LENGTH.

Rule.—Divide the circumference of the rope by 2, and square the remainder.*

EXAMPLE.

What is the weight of a 12-inch rope 120 fathoms long?

```
       2) 12
          --
           6
           6
          --
Answer    36 cwt.
          --
```

EXAMPLE.

What is the weight of a 14½-inch rope 120 fathoms long?

```
2)  14·5
  -------
     7·25
     7·25
  -------
  52·5625
        4
  -------
   2·2500
   28
  -------
  200
  50
  -------
  7·0000
  -------
```

cwt. qrs. lbs.
Answer 52 2 7

* This rule is not perfectly accurate, but may be useful in affording a clue for finding the approximate weight of ropes, especially if the circumference is in even numbers, it may then be used mentally, or by the mind only.

Table I. Showing the number of threads in the strand of a shroud-laid Rope.

Size of Rope.	Size of Yarn. Sixteens.	Size of Yarn. Twenties.	Size of Rope.	Size of Yarn. Sixteens.	Size of Yarn. Twenties.
Inches.	Number.	Number.	Inches.	Number.	Number.
2	7	9	9½	160	200
2½	10	14	10	177	222
3	16	20	10½	196	245
3½	21	27	11	215	268
4	28	35	11½	235	293
4½	36	45	12	256	320
5	44	55	12½	278	347
5½	53	67	13	300	375
6	64	80	13½	324	405
6½	75	93	14	348	435
7	87	109	14½	374	467
7½	100	125	15	400	500
8	113	142	15½	427	533
8½	128	160	16	455	569
9	144	180	16½	484	605

The difference of the number of threads in the whole rope will be found by subtracting the numbers standing under "sixteens" from those under "twenties," and multiply the remainder by 3. (Thus 256—320=64×3=192.) Therefore it appears that a 12-inch rope made of "twenties" contains 192 threads more than another, of the same circumference, made of "sixteens."

Table II. Showing the Length of shroud-laid Ropes to a cwt. from 1 to 16 Inches in circumference.

Size of Rope.	Fath.	Feet.	Inches.	Size of Rope.	Fath.	Feet.	Inches.
Inches.				Inches.			
1	486	0	0·0	9	6	0	0
1½	216	0	0·0	9½	5	2	3·7
2	121	3	0·0	10	4	5	1·9
2½	77	4	6·7	10½	4	2	5·4
3	54	0	0·0	11	4	0	1·2
3½	39	4	0·0	11½	3	4	0·9
4	30	2	3·0	12	3	2	3
4½	24	0	0·0	12½	3	0	7·9
5	19	2	7·7	13	2	5	3·1
5½	16	0	4·3	13½	2	3	11·5
6	13	3	0·0	14	2	2	10·4
6½	11	3	0·0	14½	2	1	10·4
7	9	5	6·2	15	2	0	11·5
7½	8	3	10·0	15½	2	0	1·4
8	7	3	6·7	16	1	5	4·6
8½	6	4	4·3	16½	1	4	8·5

The exact weight of a rope of any length may be found by the above table and the rule of proportion.

EXAMPLE.

Required the weight of 25 fathoms of 14-inch rope?

```
     fath. ft. in.    cwt.    fath.
As    2    2  10·4  :  1  ::   25
      6                         6
     ---                      -----
     14                       150
     12                        12
    -----                     -----
    178·4               178·4) 1800 (10·09
                                    4
                                   ---
                                   36
     cwt. qrs. lbs.                28
Answer 10   0   10                -----
                                  10·08
```

Table III. Showing the weight of shroud-laid ropes 100 fathoms in Length.

Size of Rope.	Cwt.	Qrs.	Lbs.
Inches.			
3	1	3	11·3
4	3	1	4
5	5	0	15
6	7	1	16
7	10	0	9
8	13	0	17
9	16	2	15
10	20	2	4
11	24	3	11
12	29	2	14
13	24	3	3
14	40	1	12
15	46	1	2
16	52	2	22

NOTE.—The weight of any length of rope may be found by the above table and the rule of practice.

EXAMPLE.

What is the weight of 47 fathoms of 11-inch rope?

		cwt.	qrs.	lbs.
25	$\frac{1}{4}$	24	3	11
	$\frac{1}{4}$	6	0	24
20	$\frac{1}{5}$	4	3	24
2	$\frac{1}{10}$	0	1	27
	Answer	11	2	19

The weight and circumference of any rope being given, the length may be found by the foregoing table and the common rule of proportion, or by decimals.

EXAMPLE.

What is the length of 7 cwt. 3 qrs. 14 lbs. of 7 inch rope?

```
   cwt. qrs. lbs.  fath.   cwt. qrs. lbs.
As 10   0    7  :  100  ::  7   3    14
   4                        4
   --                       --
   40                       31
   4                        4
   ---                      ---
   161                      126
                              100
                          ---------
                     161) 12600
                          ---------
                            78·26
```

OTHERWISE.

```
    cwt.        fath.     cwt.
As 10·0625  :   100  ::  7·875
                           100
                   --------------
                   10·0625)787·500
                   --------------
                            78·26
                                6
                            -----
                             1·56
                               12
         fath. ft. in.      -----
Answer    78   1   6         6·72
```

Or the length of any rope may be known by the 2d table and the rule of practice.

EXAMPLE.

What is the length of 16 cwt. 2 qrs. 21 lbs. of a 10½ inch rope?

		fath.	ft.	in.	
	½	4	2	5·4	to a cwt. by the table.
				8	
		35	1	7·2	
				2	
		70	3	2·4	
	½	2	1	2·7	
	½	0	3	3·6	
		0	1	7·8	
Answer		73	3	4·5	

ART. II.—PLAN OF A COLLEGE OF PRACTICAL MINING AND MANUFACTURING SCIENCE.*

THE President then said, that the next business to consider was the Prospectus and Report of the Special Committee as to the Proposed College of Mining and Manufacturing Science. He, therefore, begged to call upon Mr. T. J. Taylor to read the document to the meeting.

Mr. T. J. Taylor then read as follows:—

PROSPECTUS OF A COLLEGE OF PRACTICAL MINING AND MANUFACTURING SCIENCE, PROPOSED TO BE ESTABLISHED AT NEWCASTLE-UPON-TYNE.

It has long been a subject not only of regret but of surprise, that in a country like Great Britain, which for mineral wealth, and the manufactured products of such wealth, is unequalled by any in Europe, a College of Practical Mining Science should still remain *a desideratum*. Nor have inquiries been wanting, from abroad, as to the probability of some such Institution being set on foot, accompanied with intimations that support, as far as a resort to it of pupils may constitute such support, would not be wanting. As a consequence of these first suggestions, the topic has more recently engaged the serious attention of the North of England Institute of Mining Engineers, now consisting of members from all the coal-mining districts of England and Wales, by whose request the Council of that body drew up and printed a series of "Suggestions" on this important subject, in which such general details as were deemed requisite, were gone into. These may be not improperly classed under two principal heads. It was first

* North of England Institute of Mining Engineers.

discussed what locality afforded the greatest number of natural facilities for the establishment of such an Institution, and for its being afterwards efficiently conducted. And in the second place were considered, the branches of science directly or collaterally connected with mining generally, which should be taught by such an Institution. The result of the first inquiry was that, after natural advantages, central position, and local manufacturing and trading pursuits were considered and compared with those of other mining localities, Newcastle-upon-Tyne was decided upon as being, beyond question, possessed of the greatest number of these advantages, and, consequently, a site the most advisable for such a foundation. The result of the second discussion was a programme of the education peculiar to such an establishment, embracing eight distinct branches of teaching, which were deemed to be desirable for the purposes of practical engineering, as applied to mines, whether of lead, copper, tin, iron, or coal, as well as for those branches of science which bear upon the most important manufacturing processes.

In addition to these more general considerations, others of minor character were gone into and stated; and the whole being printed as a pamphlet, were circulated amongst gentlemen engaged in the coal trade and in iron-mining pursuits, so extensively carried on in Northumberland and Durham, and amongst those engaged in the manufactures of which coal, iron, lead, and their products white lead, litharge, colors, coke, artificial alkalies, machinery, &c. &c., are a constituent portion.

The wide distribution of this tract by the Council of the North of England Mining Institute gave the question a practical bearing and consequence, which it had not hitherto nor before attained, and the wished for result of thus directing attention to the subject, was the adoption of a resolution by the Delegates of the British coal and iron mining interests assembled in London, in May, 1854, to the following purport:—

"That this meeting is of opinion that it would be of essential service in the future management of mines, and consequently have a tendency to the prevention of accidents, if a central Mining School, or College, of a practical nature, were established in some convenient and suitable colliery district, with branches therefrom and connected therewith, for the education of mining engineers, or other officers and subordinate persons, to be intrusted with the management and conduct of the mines of this country. And that the Parliamentary Committee, now sitting on Accidents in Mines, be solicited to take this subject into their serious consideration, with a view of recommending the Government to afford such aid as they may deem advisable and requisite to establish an institution so necessary and laudable."

In consequence of this suggestion the Committee reported that "they would urge upon Government to foster by grant in

aid, the establishment and maintenance of Mining Schools in the large Mining Districts throughout the Country."

This resolution having been widely promulgated, together with the printed suggestions of the Council of the North of England Institute of Mining Engineers, led to a further discussion, by the delegates assembled in London, during the following year, by whom the resolution was confirmed, and the site of Newcastle-upon-Tyne named as the most convenient for a foundation of this peculiar nature.

Such is the shape which the question of a central British College of Practical Mining Science has now assumed, and, in compliance with the instructions of their constituents, your Committee now venture to state in detail such further considerations as seem to arise out of the circumstances.

Before proceeding to perform this duty, however, it is necessary to state that, as far as this district is concerned, the proposal to found such a College has already received the sanction of our great mining interest, the Coal Trade.

On the 6th February of this year, the subject was brought before a General Meeting of the Coal-owners of the Counties of Northumberland and Durham, as a portion of the Annual Report of the General Committee of the Trade. The opinions of the Committee were expressed in the following paragraph:—

"Your Committee now turn, not without gratification, to another topic, which is unquestionably indicative of the advancing state of the trade, this is the Report of the Council of 'The North of England Institute of Mining Engineers,' on the proposed establishment of a College of Practical Mining Science at Newcastle-upon-Tyne, laid before your Committee by that body, and now in the hands of the members of the trade universally. Presuming that the details of this report are known to all present, the Committee can only proceed to impress upon the lessees and lessors also of collieries and mines, the vital importance of giving the proposals, embodied in the document referred to, their best and most favorable consideration. The period has hardly arrived for the Committee to venture a conclusive opinion as to the most eligible mode of raising such funds as may be requisite to erect such an institution on a highly respectable and thoroughly independent foundation, and to secure its permanent utility when so established; but they may express their belief that such support cannot be safely left to spontaneous liberality. It appears to them, on the contrary, desirable that the wealthy and influential interests engaged in the great trades of raising, manipulating, and shipping the coal, iron, and lead, with which these counties abound, in all the forms and combinations which these materials are capable of entering into, or assuming, or are found, together with such friends to the undertaking out of these districts as may be disposed to aid it, should join in procuring

either a Charter or an act of Parliament, of such a nature as would, for a given number of years, secure the accruement of the funds necessary to give prosperity to the institution, as well as such permanent pecuniary aids as might in future time be essential to the entire utility and vitality of such an establishment. Your Committee, on the present occasion, deem it their duty to express, generally, their warm approbation of the scheme, as sketched in the Report of the Council of Mining Engineers, and their hope that the great body of the coal trade will add their efforts to promote, by a resolution of this day, this great undertaking, for which all opinions seem to concur in pronouncing this locality to be peculiarly adapted by circumstances as well as by nature, but which is, in itself, of national rather than local importance.

The result of this communication and recommendation of the General Committee to the Coal Trade, was the adoption, by the meeting, of the following resolution, passed confirmatory of the convictions of the Committee, and impressing upon the Coal Trade, as a body, the good policy of encouraging the foundation of such a College of Practical Mining and Manufacturing Science:—

"That the Meeting concurs in the Report of the Mining Institute, and in the opinion of the Committee of the Trade, that it is highly desirable to establish a College for the Advancement of Practical Mining and Manufacturing Science at Newcastle, a locality so well adapted for that purpose, and strongly recommend the Trade to support the same; and the Meeting is further of opinion that the Lessors of Mines and the Mining Interests generally of this and other portions of the Kingdom, as well as the Government, should be applied to for support to such Institution, the object of which appears to the Meeting one of not merely local but of national importance, bearing as it does upon increased skill and economy in production, and also upon the due security of life and property."

Thus, it may now be, without impropriety, assumed that the subject has received the consideration and sanction of the coal and other mining interests of the kingdom at large, as well as of the Northumberland and Durham District, and of those gentlemen in other mining localities who are members of this Institute, and by their acquirements and pursuits qualified to give active and efficient aid to an undertaking of this nature.

The Committee would now draw attention to the detailed plan of the college proposed, which seems to them to embrace the requisites calculated to make it efficient as a central school of the practical science of mining in all its branches, as carried on in European Countries.

It has been already stated that the science of practical mining seems naturally to divide itself into eight departments, which are as follows:—

1. Mathematics;
2. Natural Philosophy and Mechanics;
3. Mechanics, in their Application;
4. Plan Drawing, Surveying, Levelling, Machine Drawing;
5. Mine Surveying;
6. Chemistry, Practical and Theoretical;
7. Mineralogy and Geology;
8. The Working of Mines.

These branches, or departments, appear to the Council to include every thing directly or indirectly requisite to mining engineering, in the most extended meaning of the term. It does not, however, appear to the council to follow, necessarily, that each of these branches would require the services of a separate professor: mechanics, both in theory and application, together with natural philosophy, as far as it is connected with mining, might be taught by one professor. Plan drawing, levelling, machine drawing, and mine surveying, might also be comprised in one department and taught by one competent person.

There remain,

Chemistry	1	Professor.
Mathematics	1	Do.
Mineralogy and Geology, and Working of Mines	1	Do.

A competent knowledge of the subjects taught by these five professors may be acquired by a diligent pupil in two yearly courses, extending over six or eight months in each year, divided into two or more terms; but it may be desirable to adopt a course of instruction for a period of three years, and also to make arrangements for admitting managers of mines, or pupils of mining engineers or mechanics, wishing to avail themselves of the college for a limited number of terms or classes in each year.

The College might also be open to young men, who may become students of, or who may wish to attend a course of lectures on any particular branch of science.

The College ought to maintain a scientific, combined with a thoroughly practical character. The situation of Newcastle, in the midst of the most extensive and difficult mining concerns in the kingdom, peculiarly adapts it as the situation, above all others, where sound practical knowledge can be obtained; an advantage, the absence of which has been severely felt by similar institutions on the continent, rendering the course of instructions at these universities more of a theoretical than a practical nature, though the acquisition of knowledge is duly appreciated and adopted, wherever it is possible to engraft it upon the usual course.

With a view to bear out the practical character of the institution, it is proposed that pupils shall not be eligible for the honors it may have to bestow, unless they have had two years

actual experience in the mine or manufactories. This rule, however, is not meant to exclude persons who may wish to attend particular courses of lectures without laying claim to the privileges the college can confer. Foreign students will be admitted on certificates that the rules for admission have been complied with, whether in their own country or elsewhere. The teachers or professors and pupils, are proposed to have access to the mines and to the manufactories under arrangement with the owners; and to make periodical tours into the mining districts, to study the geological features of the coal and other formations, and their associated rocks and minerals.

It is proposed that the students be examined annually on their progress in practical and scientific knowledge, in such manner and by such persons as shall be prescribed by the rules of the institution, or which shall, from time to time, be laid down and appointed by the Governors; and certificates of progress and standing shall be awarded to the pupils who shall pass the required examination, with certificates of honors or proficiency, as may be determined by the Governors, and embodied in the constitution of the establishment. The question of honors, by degrees or otherwise, to be conferred by the College, involves a variety of considerations, and may properly, in the estimation of the Council, be left to the arrangement and decision of the governing body.

The fee for admission is proposed to be *twenty pounds* in one payment in advance; or two annual payments of *twelve pounds* each, for the whole course. Separate arrangements to be made for fees of attendance on particular classes; and young men engaged as practical miners to be admitted at such reduced fees as may be determined by the governing body. Donors of *one hundred pounds* to be entitled to nominate a pupil on payment of half the usual fees; and for every like sum, as many pupils on the same terms.

All matters connected with the funds, and with the district and central establishment, to be under the management and supervision of a Board of Governors.

Though the institution is intended to be self-sustaining, its first establishment, with a proper building, class rooms, and apparatus, will involve the expenditure of a considerable sum. To the lessors and lessees of mines, as most interested in the subject, the Council naturally look for the most efficient support. The corporations of Newcastle and of the other large towns in the district may be also expected substantially to aid the project. Neither can the Committee forbear from noticing that there are surplus funds arising out of the mines in the diocese of Durham, the application of a portion of which to the protection of life and property in those mines would surely be a very suitable appropriation.

The annual expenditure of such an Institution, including the salaried officers, such as registrar, curator, door-keeper, &c., &c., also moderate endowments of the professorships, but exclusive of interest of money sunk in building, would require a revenue say of £3,000.

With regard to the building requisite, the council may refer to the elevation and ground-plan furnished by Mr. Archibald Dunn, and constituting the frontispiece to this prospectus. The cost of the building is estimated at £16,000. The entire capital required to be raised, including the purchase of suitable apparatus and endowments for professors, is estimated at £35,000. Two obvious methods suggest themselves as means of raising and securing the funds necessary for the proposed undertaking. The first of these is to obtain an Act of Parliament, with the assent of all interested, for the levy of a small *percentage*, payable to trustees for this specific purpose, and calculated upon the values or tonnage of the coals, iron, lead, copper, and tin, raised by those who are parties to the act; the second is a voluntary subscription, covenanted for in a trust-deed of mutual agreement, to be signed by the parties, and having the force of a legal agreement or bond, vesting the property in trustees. At this stage of the undertaking the council do not deem it necessary to do more than give a general idea of the trifling amount of *percentage* upon the products enumerated, amply sufficient to raise the sum required; whether this district alone be considered, or the mining interests of the other mining localities of Great Britain be included.

In the valuable statistical returns, compiled by Robt. Hunt, Esq., keeper of mining records, and by him presented to the library of the North of England Institute of Mining Engineers, are given the totals as well as the detailed particulars of all the coal, iron, tin, lead, copper, and silver raised, or smelted, in the United Kingdom, together with values:

	Tons.	Value.	
Coal	64,661,401	£14,975,000	(at Pits.)
Tin	5,763	690.000	
Copper	13,042	1,229,807	
Lead	64,005	1,472,115	
Silver, 700,000 ounces		192,500	
Iron, (pig)	8,069,888	9,500,000	
Zinc		16,500	
Arsenic, sulphur ores, and sundry minerals		500,000	
		£28,575,922	

On coal only, therefore, a tonnage of so small an amount as the 1-90th of a penny per ton (a penny for every 90 tons), would raise a sum of £3,000 a year. Or a payment of twopence-half-penny in every one hundred pounds value of the mineral produce of the United Kingdom, would raise the like annual amount of £3,000.

But whilst the contribution thus required to raise the requisite funds is of so trifling an amount that it would entail upon a colliery, vending 6,000 tons yearly, a payment of only £2 15s. per annum; yet, considering the difficulty of collection over so wide an area, the possible opposition of particular coal owners to a parliamentary tax, and having regard especially to the circumstance, that the proposed institution may be expected, not unreasonably, to be self-sustaining, the committee lean to the opinion, relying upon the great individual interests connected with the mineral produce of the kingdom, that the plan of a subscription would be the preferable one.

To this course they do not yet, however, pledge themselves. Indeed their position is such, that they must first feel their way and permit themselves to be governed in a great measure, by future events; expressing, at the same time, their conviction that a project, having for its purpose the establishment of an institution so directly bearing upon economy in production and upon the preservation of life, cannot be, as it ought not to be, otherwise than eminently successful.

The president, at the termination of the paper, observed that having just heard it read, it was for them to judge whether they should adopt it or not; if they agreed to adopt it, the committee were still willing to receive any recommendation from any member likely to promote the general object in view.

Mr. M. Dunn thought they could come to no decision on the subject without an Act of Parliament.

Mr. Taylor replied, that it would be a very difficult thing to get an Act of Parliament upon which the coal owners of England and Wales would all agree.

Mr. Dunn—But they could not secure a revenue without an Act of Parliament.

M. Taylor—The numerous pupils would be a source of revenue without it.

The president observed, that as a beginning they only required £35,000, and he thought it indeed a very extraordinary thing that such a sum could not be raised among the lessors and lessees of collieries, aided by the corporation of that town and the manufacturing interests in the vicinity, and the other parties interested in the college belonging to different parts of the kingdom.

Mr. Dunn—If they agreed upon the voluntary principle, would it not be proper to lay down some rule for receiving subscriptions.

Mr. Taylor objected to such a course being adopted, as he felt confident that several parties connected with the coal trade would come forward handsomely, and subscribe large sums without any dictation as to what they should subscribe.

The president coincided with Mr. Taylor, as he thought it not

desirable to lay down any scale of subscription. If parties agreed to a scale beforehand that would alter the matter. At present, after passing the report before them, they might propose a resolution recommending that efforts be made to obtain subscriptions; and if, in a short time, after appealing to certain noblemen and gentlemen in the trade, they realized £10,000 or more, that in itself would be a good beginning, and set an example to other parties to come forward. The necessity and importance of the college was such, that he could scarcely doubt the most successful results from a well organized plan for securing subscriptions. With their permission he therefore begged to submit the following resolution to their notice:—

That the prospectus read be approved of and adopted, and that it be printed and circulated; and also that a committee be requested to take such steps as may be requisite to procure subscriptions for the establishment and support of the proposed college.

The president then put the above motion, which was carried unanimously; after which he said that the only subject for discussion seemed the resuming of Mr. Atkinson's paper.

Mr. T. J. Taylor, however, begged to say that he understood that the discussion was adjourned at the last meeting, until the committee appointed should make certain experiments, the result of which is to be reported hereafter.

The president remarked that the next paper in order of discussion was his own upon the conveyance of coals underground, and he should be glad to hear any observations upon it, as it was a subject of great importance in an economical point of view.

A long and desultory conversation ensued upon the subject; after which it was ultimately agreed to postpone the discussion of the subject until the next meeting, it being argued that as the subject was of such great importance, it required more time for consideration.

Art. III.—ON THE WORKING OF THIN SEAMS OF COAL, WITH OBSERVATIONS ON LONG WALL AND BOARD AND PILLAR WORK. By C. C. Greenwell.

I am induced to make some remarks upon this subject by a consideration of the system of working pursued in some of the more highly favored coal districts of this country.

In these we find that seams of coal of 2½ feet, or even more

than this in thickness, are considered as unworkable to profit, and are, therefore, not only left in the mine untouched, but so little regarded as in many cases to be rendered utterly worthless, even at any future day, by the working of the more profitable seams lying in their vicinity.

I do not mean to say that I can prove that a thin seam can be worked as cheaply as a thick one; but that a thin seam can be produced as cheaply as a thick one, with even a moderate freight added thereto, I trust I shall be able satisfactorily to establish. And when we consider the enormous rapidity of increase in the quantity of coal annually required, especially in those districts which have large deposits of iron-stone nearly associated with them, and when we contemplate the fact, that in some of the large seats of the iron trade, coal bountifully deposited, is already beginning to be seriously exhausted, we cannot, I think, but feel that it would be in the highest degree unwise, from a mere want of common prudence and foresight, to hasten the day when plentiful supplies of iron ore will lose their value from the want of cheap fuel to reduce them to their metallic state.

On reference to a section of strata throughout the Newcastle coal measures, recently published it will be seen that there are no fewer than fifteen seams of coal under two feet six inches in thickness, and varying from twelve inches to twenty-eight inches both inclusive, all considered unworkable, and amounting in the gross to twenty-five feet seven inches.

The whole lies within 280 fathoms of coal strata; and when it is taken into consideration that half of the above quantity of coal would supply a demand of 20,000,000 tons annually for somewhere about 400 years, I trust that the subject will not seem unworthy of the attention of the North of England Institute of mining engineers.

It must not be forgotten that the day will come when the thin seams will be of greater consequence than the thick ones.

In the collieries of the neighborhood of Bath, in the upper house coal series are *seven workable seams*, the aggregate thickness of which is twelve feet, occasionally worked in a section of 200 fathoms of coal strata, some of the pits are even deeper, but the average depth is 140 or 150 fathoms.

Three of the seams worked vary from twelve inches to sixteen inches, and four vary from two feet to two feet four inches.

It is not necessary in this place to enter into details of machinery, or of underground or upperground transit, but, as I conceive, simply to describe the mode and cost of getting the coal and of making underground roads, as all other expenses can of course be conducted as cheaply in thin seams as in thick ones.

In order as fully as possible to show the cost of the above, I shall not take an average of se ms, but show the costs in what are termed the thin seams and thick seams severally.

The whole of the coal is worked the "long way," and, according to the fancy of the manager, either by a series of heads driven on the level of the seams, one to the rise of another, or driven on the rise of the seams, each having a road formed up its middle.

Often, however, the strata are so faulty, and the rise so variable in direction and amount, that no regular system can be pursued, and then the heads are driven as most convenient. When the heads are driven on the level, the lowest road would have the coal along its deep side, unless a strip were worked out along with the head; in practice this is essential to the maintenance of the road, for with a coal side the roof is always found to break to a considerable extent, and to require a constant renewal of timber; whereas, under the system adopted, no timber at all is most frequently required.

When the heads are driven on the rise, a drift, or level head is first driven, with the same precaution of removing the coal for a few yards on each side of what is intended to be the permanent road.

Having, in the North of England, often seen the difficulty of keeping up the roof in narrow places, and particularly in deep pits, I would suggest the trial of the plan described; the sides of the road being (as in Somersetshire) stowed up with any stone that can be got, from the roof or otherwise.

When I first commenced practice in Somersetshire, I found all the roads in the goaf, and the expense of their maintenance, in many cases, considerable. I thought that by leaving a barrier of coal on the side of these roads, the expense of their support might be moderated, and as an experiment, I left thirty yards of coal on each side of a main road at the depth of 126 fathoms, the thickness of the seam being two feet two inches.

The result did not answer my expectations; the thill heaved worse by far than before, and, in fact, until there was no more soft thill to heave, the whole having been picked up to keep the necessary height of road way, and then the roof began to fall. The experiment was tried for 100 yards, for a period of six months and then discontinued, the whole of the coal being thenceforth removed. Beyond the 100 yards (and where now in work) the roof is firm; the coal is good and the country quiet.

To describe more particularly, the thickness of coal is two feet two inches, the roof is blue metal, and the thill soft black metal about eight feet in thickness. Immediately under the coal the thill is so soft as to be undermined in. I then directed the pillars to be entirely removed from the sides of the main road, which is now in progress; already the place is much easier, and I have no doubt when they are gone, the road will be as quiet as the rest of the roads are.

I may repeat that before the roof began to break all the softest of the thill had been picked up, and this may throw some light upon the breakage of roofs.

I shall now proceed to the question of the hewing or getting of the coal, and its drawing to the main roads.

If we take the gross quantity of coal obtained in a certain time by a given amount of manual labor, as a criterion, it will not require much argument to show that the thicker the seam, *ceteris paribus*, the more coal will be worked.

But we must give due consideration to the fact, that in general it is our chief object to produce large coal, and that there are economical and wasteful modes of effecting this, as well as of conducting other matters.

In order to show what can be done by the long way of working, I give the area worked, thickness, and absolute produce of the several seams of coal at Radstock in the year 1855, from which it appears that a gross mine content of 122,082 tons produced of saleable coal 99,863 tons, besides 8,840 tons required for colliery consumption.

Seams.	Thickness.		Area Worked.	Contents per acre.	Gross contents of area Worked,
	ft.	in.	Acres.	Tons.	Tons.
Great Vein........	2	2	2·6955	3370	9,083
Top Little Vein....	1	4½	7·6527	2139	16,369
Middle Vein	2	0	5·5724	3111	17,335
Slyving Vein	2	3½	7·9026	3565	28,172
Under Little Vein .	1	2	8·2756	1815	15,020
Bull Vein..........	2	3½	10·1272	3565	36,103
Total..........	....		....	....	122,082

Which is accounted for as follows.

SALES.	TONS.	PER CENT.
Round	89,755	73·52
Small	10,108	8·27
Sold............	99,863	81·79
Colliery Consumption..................	8,840	7·24
Loss underground at Faults, and small Coal not landed........	13,379	10·97
Total............	122,082	100·00

I am not prepared to say how much of the above 10·97 per cent. consisted of small coal purposely stowed underground, but imagine that it would not be less than half, reducing the quantity actually lost in working to 5·48 per cent. According to the board and pillar practice of working seams of coal from 4 to 5 feet in thickness, I believe that it will be found that 11 per cent. at least,

is lost underground, leaving 89 per cent. as the quantity drawn to bank in altogether work, of which, on the average, not more than 66 per cent. or 58·74 per cent. of the entire mine is sold as merchantable round coal.

And from a comparison of the above calculations, it will appear that 58·74 feet in thickness, made up of the thin seams described and worked by the long wall, produce as much round coal as 73·52 feet in thickness made up of seams four or five feet thick, worked by the board and pillar method.

A thin seam worked by board and pillar makes more small than a thick one, and it may, therefore, be safely said that by the long wall mode as much round coal can be got out of a seam of coal two feet in thickness, as by the board and pillar method out of a seam two feet nine inches, or possibly three feet.

Each head of coal is usually (where practicable) made about sixty yards in width, in which are placed four men. If the head is driven on the level, there may be ten yards of dip side and fifty yards on the rise side of the main road, which is made wagon-way size into the face.

In order to bring the coal from the high side to the wagon-way, branch-ways, or, as they are called, twin-ways, of smaller size, or three and a half feet in height, are also carried up to and dividing the face, so as to have about ten yards of face, on each side of the twin-way.

If the head is driven to the rise, the wagon-way is made up the centre of the head, also into the face, and a branch or twin-way carried from each side into the face as above.

In bringing the coal to the wagon-way we have, therefore, three distinct sets of operations.

1. *The Hewing or Breaking.*—This is performed by undermining, or, as it is called, "benching," in a pricking or swad, which usually is found of the thickness of two or three inches under the seams of coal, it is sometimes thicker and sometimes thinner.

The benching is usually worked under the coal, from eighteen inches to two feet along the face, when the coal falls without the use of gunpowder or wedges; a few inches of the roof often fall with the coal.

The breaker then secures the roof and throws back the stone or rubbish into the goaf behind; he also forms pillars of stone occasionally for the support of the roof, but this more properly belongs to another department.

The prices paid for the above are, for seams averaging two feet two inches, about 1s. 1d. per ton; and for seams averaging one foot three inches, 2s. 2d. per ton, paid on the produce of round coal.

2. *Carting.*—This includes bringing the coal from where it has fallen, to the twin-ways. It is in the case of the thin veins commonly drawn on boards, and in the thicker ones on puts or sledges. The persons employed at this work also pack the coal upon

the carriages for the purpose of being taken along the twin-ways to the wagon-ways.

The cost of carting in the thick seams amounts to about 8d., and in the thin seams to 1s. 2d. per ton on the round coal sold.

3. *The Twin-work* consists of bringing the coal along the twin-ways to the wagon-ways; its cost under favorable circumstances, or where the dip of the seams is moderate, and their regularity as great as in the Newcastle coal-field, is about 3d. per ton on the round coal, but where the inclination is very great or the ground faulty, it often costs more.

If to the above items be added the cost of pillaring in the face, making the twin-ways, wagon-ways, and air-ways, and pillaring on the sides of these, also the removal of rubbish out of thin seams into thick ones, all of which expenses are consequent on the working of thin seams of coal in the long way, we arrive at certain amounts, beyond which expenses are common to seams of coal of whatever thickness and however worked.

These expenses are as follows:—

1. *Making Roads.*—These consist of twin-ways, air-ways, and wagon-ways, and the pillaring up of their sides, and the cost of this for the thick seams is 5¼d. per ton, and for the thin ones 6¼d. per ton, on the round coal sold.

2. *Deading.*—Which comprises maintaining roads and air-ways, upon which, until they become settled, there is a great deal of heaving and lowering way, pillaring up stone in the face, removing rubbish from them into thick seams, &c., &c., and costs in both about 7d. per ton on the round coal sold.

The following is an abstract of the above costs:—

	THICK VEINS.		THIN VEINS.	
	Per ton.		Per ton.	
	s.	d.	s.	d.
1. Breaking	1	1	2	2
2. Carting	0	8	1	2
3. Twinwork	0	3	0	3
4. Making Roads	0	5¼	0	6¼
5. Deading	0	7	0	7
Total	3	0¼	4	8¼

I shall now compare with the above the cost of working by the board and pillar method upon round coals, an average seam of coal, say four feet in thickness, and similar in hardness to those above described, taking the items of labor which are parallel with the above into calculation. I take the average costs of working at an average Five-quarter, Low Main and Hutton Seam Colliery of the North of England, which are as follows:—

	Per ton. s.	d.
1. Hewing and Narrow Work....	1	10
2. Putting and Helping-up.......	0	4½
3. Deputy Work..................	0	2
4. Making Wagon-ways.........	0	2
5. Shift Work.....................	0	1½
Total................	2	8½

From this it appears that by the long way of work a seam of coal two feet two inches in thickness, can be worked within 4d. a ton of the cost of a four feet seam, worked by board and pillar, and a seam fifteen inches thick at about 2s. per ton higher, calculated upon round coals in both cases.

Or to place the matter in a stronger light, a seam of coal two feet two inches thick, near to the shipping place, could be put on board as cheap as a four feet seam half a dozen miles from it. Thirty miles of shorter carriage would probably make it worth while to work the fifteen-inch seam.

The relative ages of the work people employed in the thin seams is interesting, and shows the number of young persons to form a large proportion of the whole.

The following table presents the number of work-people employed underground in the East Somersetshire Collieries, with the proportion employed during each quinquennial period (1855.)

AGES.	NUMBER.	PER CENTAGE OF EACH AGE.
10 to 15..........	621	23·381
15 to 20..........	458	17·244
20 to 25..........	335	12·613
25 to 30..........	279	10·505
30 to 35..........	218	8·208
35 to 40..........	189	7·116
40 to 45..........	170	6·400
45 to 50..........	128	4·819
50 to 55..........	100	3·765
55 to 60..........	83	3·125
60 to 65..........	50	1·882
65 to 70..........	15	0·564
70 to 75..........	10	0·376
75 to 80..........	0	0·000
Total..........	2656	100·000

The quantity of large and small coal worked in the district in 1855 was about 400,000 tons, which is equal to 150½ tons per head.

According to Mr. T. Y. Hall's calculations, the underground labor of the North of England produced in 1844, 382½ tons per head, and in 1854, 494 tons.

I do not observe that the more recumbent position of the workmen in the thin seams produces any injurious effects physically, nor do I think that any comparison between the working classes of these seams with those who are employed in thicker ones, is by any means disadvantageous to the former class.

The number of fatal accidents during the year ending June 30, 1855, was, in the East Somersetshire district, 5, as appears from the report of the Government inspector, Mr. H. Mackworth.

This is equal to 1·882 per thousand persons employed, or 1 for every 80,000 tons of coal.

Four of the above were shaft accidents, equal to 1·506 per thousand persons, and one was caused by fall of roof, equal to 0·376 per thousand. I believe, however, that since the above date only one life has been lost in the district, that also in a shaft.

The above does not compare unfavorably with the return of the Government inspector for the North of England, Mr. Dunn. According to his report for 1854, the number of fatal accidents was 104, which is equal to 3·851 per thousand persons employed, or 1 for every 128,201 tons of coal.

Thirty-three of the above deaths were caused by falls of stone and coal, equal to 1·222 per thousand persons, and twenty were shaft accidents, equal to 0·747 per thousand, and equal together to 1·969 per thousand, or about the same from these causes as in East Somersetshire.

There is, undoubtedly, less liability to accident from fall of roof in a thin seam than in a thick one, when the quantity of coal worked is in proportion to the thicknesses of the two seams; otherwise, for the same quantity of coal, there is twice or thrice as much roof to work under in the former as in the latter instance, and, consequently, liability to accident must be greater.

I believe also, there is considerably less risk of accident in working by the long way than by the board and wall. By the former method new and firm roof is exposed daily, the roof of two days old being stowed up and supported behind, and the space between the pillaring and the face, probably not exceeding four or five feet, and even that propped with timber where necessary; whereas, in the board and pillar mode, the same roof is almost always exposed for a month and often much longer, supported by timber only. In working off the pillars, the danger is certainly much greater than in long work.

Art. IV.—SIMPLE PROCESS FOR EXTRACTING COPPER FROM ITS POOR ORES. By W. J. March, M.E.

This process for working up copper ores that are too poor in metal to bear transportation from the mines, is very old, and has long been practised in Europe. Yet its introduction into this country, I believe, is new; and with the alteration of a few of the details that I have made to it, to render the operation more

speedy, will make it a very desirable acquisition to a great many of the mines in this country.

Its simplicity, and also the trifling expense at which it may be started and kept going, is also a great recommendation in its favor.

It consists simply, first to convert the ore into a sulphate by burning in heaps with brushwood, or roasting in a furnace; then lixivating the burnt ore, and precipitating it with old iron.

In order to comprehend the details of the operation more readily, I will give them separately.

1st. *Roasting or Calcining the Ore.*—The entire success of the whole process will depend upon this being well done. In the first place, the ore should contain from 20 to 30 per cent. of sulphur, either mineralized with the ore, or in the state of mundics, or pyrites; should the ore not contain the requisite amount, mundics, or pyrites, must be added to it; should there be more, it will be all the better, only more liable to melt.

I have found twenty-five tons to a heap the best size for complete work at a single roasting; I therefore give the dimensions for that size:—

First, six logs about a foot or nine inches through, and twelve feet long, must be laid parallel to each other, and a little over two feet apart, so as to cover an area of twelve feet square. (The logs may be in two lengths, and placed end to end.) The vacancies between the logs must be filled with small dry wood that will kindle easily; then covered with poles or rails twelve feet long, and three to six inches through, laid across the logs and close together, in order to prevent the ore from falling through too soon. Then throw a layer of brushwood on the platform thus made, and cover it with ore, and keep putting on alternate layers of brushwood and ore, sloping in the sides about 50 to 55 degrees, until the twenty-five tons is all on the heap, it will then be about eight feet high. It is now finished, and can be set on fire at pleasure; firing the alternate ends of the five furnaces, three to windward and two to leeward. It must then be allowed to burn until it goes out.

Larger sized heaps should have chimneys through them, made by placing three good-sized poles together on end in the heap. Even one or two in the above size heap I believe is a great advantage.

If the ore does not contain above 4 or 5 per cent. of copper, one burning, if well done, will be sufficient to convert it all into sulphate—should it contain above that amount, it will take from two to three burnings.

Roasting the ore in a reverberating furnace would be much more complete and speedy, but the cost would be much increased.

2d. *Leaching the Burnt Ore.*—After the ore has become cool, it is thrown into large hoppers, and warm water thrown on it a regular intervals, sufficient to keep it running steadily. Col

water will answer, but the warm dissolves it more rapidly, and it is sooner leached out. The water can easily be warmed by plunging hot iron into the buckets before throwing it on the hoppers. When the water from the mines is used, heating in an iron vessel would not answer, as the water always contains a notable quantity of sulphates, which would soon destroy the vessel used.

The hoppers are kept running until the water becomes so weak as to hardly coat a knife blade; it is then emptied, and fresh unleached ore put in its place.

3d. *Precipitating the Solution.*—The solution as it comes from the hoppers is thrown into barrels, tubs, or vats of any size (I think fifty to seventy-five gallons the best size); to which is added old iron, such as broken castings, and scrap iron of any sort, but cast-iron works best in cold water.

The iron is put in proportion of about four pounds to the gallon; it should be disposed in the tubs in such a manner as to expose as much surface of metal to the action of the water as possible, and to reach nearly to the top of the tub, as the strongest action is from the surface to the centre.

As there is usually two or three parts sulphate of iron, to one of sulphate of copper present, the solution consequently does not remain long clear. While it froths freely, it is doing very well; but when the sulphates commence to crystallize on the surface, and slimy flocks of hydrate of iron are seen floating about, the iron must be taken out, the water allowed to settle, and the clear portion of it syphoned off; the remainder, which is principally sulphates, and hydrate of iron, by filling up again with clear water, are redissolved and so much disseminated, that by putting back the iron, the remainder of the copper in solution is soon precipitated.

In the water that has been syphoned off, more iron is added, and it will precipitate itself without further trouble.

When the water will no longer coat a knife blade, the copper is all out of it. In cleaning off, the iron is scraped clean off the copper attached to it, and put aside for further use. If it is intended to convert the mother water into crystallized sulphate of iron (copperas), the clear portions only must be used for that purpose. The remainder is diluted until the copper is washed clean from the hydrates and carburets of iron. It is then ready for melting into ingots, or boxing up and selling to the smelters.

I have found that the precipitation is very much hastened by putting the solution and iron into a copper boiler, and keeping it almost to a boiling heat until the copper is all out, merely taking care that the solution is not enough to throw down too much hydrate, which retards the work.

A fifty-gallon tub would take about eight days of summer weather to precipitate in cold solution, while a fifteen-gallon

boiler would precipitate forty-five gallons in twelve hours, and use a smaller proportion of iron to work with.

It takes one pound of iron to precipitate a pound of copper, there being considerable waste through "graphite" and other impurities in the iron.

The cost of working this process would of course vary in different sections of country, but in order to give some idea of its trifling expense, I subjoin the costs of three lots that I manufactured with particular attention as to the expense; merely prefacing, that the ore I used was a mixture of decomposed sulphurets taken as it came from the mine, and required no addition of sulphur being made to it:—

	No. of Tons Burnt.	Percentage in Copper.	Percentage in Sulphur.	Number of Times Burnt.	Cost of Burning per Ton.	Cost of Leaching and precipitating a Ton.	Percentage of Copper left in Ore after Leaching.	Pounds of Iron used per Ton of Ore at 2c. per lb.	Pounds of Copper made to Ton of Ore.	Total Cost per Ton.	Total Value per ton.
No. 1.	20	3.00	55.00	1	7½c.	$1,40	0.25	64	53	$2,75½	$18,25
No. 2.	10	6.00	40.00	2	8c.	1,65	1.10	120	96½	4,21	24,12½
No. 3.	6	8.00	30.00	2	8½c.	1,90	2.75	145	104½	4.97	26,12½

It will be perceived that there is a loss in metal in Nos. 1 and 2 in the precipitating, to the amount of 0.20 per cent. in the ton; this cannot economically be avoided in precipitating with cold solution, as it is better to waste that small amount than allow it the increased time required to precipitate.

In No. 3, the loss is only about 0.03 per cent. in the ton, this having been precipitated in hot solution by boiling, was more readily cleared, which accounts for its coming so near the assay.

I should have remarked, under the head of burning the ores, that the very sulphurous ores being easily fused, are apt to deposit more or less regulus at the bottom of the heaps; this, it is needless to say, should not be put into the hoppers. Yet, as it is usually several times richer in metal than the ore, it may, if rich enough, be sold to the smelters in that state. But if too poor to bear transportation, it can be put in the bottom of the next heap, where it will be remelted, and come out rich enough next time.

In No. 1, I found 600 lbs. regulus containing 7.30 per cent. copper.

In No. 2, in the second burning, I had 400 lbs. of 13.25 per cent. copper.

In No. 3, in the second burning, I had 560 lbs. of 14.00 per cent. regulus.

A neighboring company, in a heap of about 40 tons of 9.00 per cent. ore, procured 1,800 lbs. of regulus, that reached 15.00 per cent. in one burning.

Art. V.—ON THE GASES AND VENTILATION OF MINES, MORE PARTICULARLY COAL MINES.

(Continued from page 322, vol. IX.)

2. Artificial Ventilation.

a. The Waterfall.—This may be effected by allowing a portion of water to fall down the downcast shaft, which produces a very good current of air if the water be in any considerable quantity, and the fall be great.

The effect of a waterfall, consisting of a quantity of water passing through two holes, one inch in diameter each, and flowing sixty-three fathoms, may be judged by the following experiment made at Blackboy Colliery, May 8, 1845. The colliery was at this time ventilated by a nine-feet furnace, and the experiment was made in one of the working districts, previous to and after subdividing the portion of air applied to its ventilation.

1. *Before Splitting the Air.*

	Cubic feet.
The quantity passing into the district with the furnace alone was	8,394
After putting on the waterfall it was	11,565
Increase due to waterfall	3,171

2. *After Splitting the Air.*

	Cubic feet.
The quantity passing into the district with the furnace alone was	11,313
After putting on the waterfall it was	13,687
Increase due to waterfall	2,374

The reason of this reduced increase will be explained hereafter, when we discuss the important question of resistance.

Although in cases of emergency the waterfall may be applied as a useful ventilating power, yet it is subject to great objection on two accounts; for it occasions the return into the mine of a considerable quantity of water, which is to be again drawn out, and it so produces a dampness in the air which is very injurious to the timber used in the mine, causing its rapid decay. After an explosion, when the furnace is inaccessible, it is a ready way, as causing a circulation of air through the mine; but excepting in extreme cases, or when it is necessary to suspend for repairing the ordinary ventilating power, it is a means of ventilation which cannot be recommended.

b. THE FURNACE.—The system of ventilation usually adopted, consists of a furnace or fire placed near to the bottom of the upcast shaft, for the purpose of rarefying the air contained therein, and should be adopted in the first instance in hot weather, on the failure of the ventilation produced by natural causes.

The theory of the action is as follows:—First, that the velocity of the ventilating current increases with the temperature of the upcast shaft, because the velocity of the current increases with the length of the motive column, which, other things being equal, depends on the temperature of the upcast shaft. The converse of this, although not for the same reason, is also true; viz., that the temperature of the upcast shaft, other things being equal, depends on the velocity of the air current; or, in other words, if by using an addition to the furnace, any mechanical or other means, we increase the quantity of air, we shall find such increase to be in a greater ratio than is due to the mere mechanical agent employed, inasmuch as we shall find a higher mean temperature in the upcast, and the motive column increased in a corresponding degree, owing partly to the fierce combustion of the furnace, and partly to the more rapid travel of the hot air up the shaft, and consequent higher point which it attains before losing its temperature by absorption, radiation upwards, or whatever cause produces that diminution in heat which takes place so rapidly.

Second, the quantity of air depends upon the air channels being shortened and made of as large area as possible.

The shortening of the mine channels may be effected in a great degree by splitting the air, as it is called, or dividing the main current of the downcast shaft into subordinate currents, each having a separate district to ventilate, instead of causing the main current to travel in an undivided state through the whole of the ramifications of the mine, besides the effect of shortening the run of the air, the other requisite, viz. that of enlarging the average area of the air; channel is also produced by splitting the air. In splitting the air two points require particular attention.

1. Not to carry the principle too far, otherwise each split will be feeble and inefficient.

2. To have large channels before splitting the air, and also after the divisions have been reunited.

If any district of a mine evolves so large a quantity of fire-damp, that its being mixed with the rest of the return air would raise the whole current to the firing point, the split of air which ventilates such district must of course be taken into the upcast shaft by some other means than by that of the furnace. A drift is therefore driven in fiery mines from one of the returns into the upcast shaft, by means of which any division of air which is of a dangerous character, may be conveyed into it. The point of delivery into the shaft of such a drift, should not be less than 8 fathoms above the furnace to drift end, so as to preclude the possi-

bility of the inflammable gas being ignited by any ascending flame. There are cases in which the whole of the return air must pass into the upcast, without contact with any flame, in which case the furnace must be fed entirely with fresh air from the downcast shaft. In order to regulate the quantity of air which it is desirable to pass through each district, a description of door is required, which should be 6 feet wide by 3 feet 6 inches in height, fixed in a frame and divided vertically into halves, one of which is movable behind the other half, which is fixed. This frame is placed in any single return from the districts where the air has the shortest distance to travel, and is opened sufficiently wide to allow the requisite quantity of air to pass through. There ought to be means provided, by lock or otherwise, of securing the slide in the required position, to prevent any ignorant or mischievous person from altering the proper distribution of the air.

In all fire-damp mines requiring, in consequence, an active ventilation, the necessity of having large air-ways is paramount to every other consideration.

The essentials to produce a good furnace ventilation may be shortly summed up as follows:—

1. Powerful means of heating the air.

2. Length of heated column, which in shallow mines may be augmented by a tube, or chimney, of the size of the shaft, and erected over it.

3. Short air-courses (equally requisite, whatever be the ventilating power employed).

4. Large areas of air channels (ditto).

It would be superfluous in this place to state the lengths or dimensions which ought to be given to upcast shafts or air-ways; because the circumstances of all mines are so varied, both as regards their extent and the quantity of air they require in order to their being sufficiently ventilated, that no fixed rule would be found applicable to any one mine for any length of time. A few remarks, however, on the construction of furnaces may not be out of place:—The essential of a complete furnace is, that it should possess abundant power of heating, to a high degree, a rapid current of air of large dimensions.

It is an error to suppose that it is necessary, in order to heat the air to a high temperature, that it ought to be forced through the bars of the furnace, for air should be *forced* nowhere. The fact is, that so great is the radiation of heat from the furnace, that when properly constructed and attended to, it is capable of heating many times the quantity of air which usually passes over it, to as high a temperature as that which ordinarily pssses into the upcast shaft.

In the construction of ventilating furnaces, the general mistake is to raise the bars too high, which has the effect of contracting the air-way above the fire, and thus produces an injuri-

ous effect. The furnace may be placed near the bottom of the shaft, if used exclusively as an upcast, but should be 50 or 60 yards distant from it, if the shaft is used as a winding shaft also, or in cases where gas or dumb-drifts are necessary; the drift from the furnace ought to have an inclination upwards towards the pit of not less than 1 in 6.

STEAM.—In the first report of the Society for Preventing Accidents in Coal Mines, written in 1814, by Mr. Buddle, is a drawing and description of a steam ventilator, by which steam is carried down and discharged in a shaft from a boiler placed at the surface. The steam in this was delivered downwards into the upcast shaft, and the ventilation to be produced was entirely dependent upon the temperature arising from the steam. The next attempt at steam ventilation was made in Wales, by Mr. Stewart, in 1828, but the system was not found to produce the effect required, and consequently abandoned.

The steam blast applied to the locomotive engine, having proved so admirably effective in producing that violent draught of air so essential to its wonderful concentration of power, induced Mr. Gurney to conceive that great benefit would arise from its application in somewhat similar manner to the ventilation of mines; and we find that in July, 1855, before a parliamentary committee, appointed to inquire into the causes of accidents in mines, and in October, 1839, in a letter addressed to a similar committee, that gentleman explained at length his views upon the subject.

There is no doubt that cases will occur, for instance, as in the early working of a very fiery seam of coal, or in the re-opening of abandoned mines, infested with fire-damp, where the steam jet may be applied with advantage, but in such instances as these no great *quantity* of air is requisite; but as regards the amount of air to be obtained by the furnace and by the steam jet in comparison, the following quotation from a paper communicated to the North of England Institute of Mining Engineers, by its president, Mr. Nicholas Wood, seems conclusively to settle that point:—

"In conclusion, the practical result of all these experiments is, that within the limits or range of furnace ventilation, the steam jet acting as a *substitute* is attended with an increase in the expenditure of fuel of nearly 8 to 1, without any corresponding advantage, either in the steadiness, security, or efficiency of ventilation; on the contrary, from its economy and its efficiency in cases of emergency, the furnace is a more secure, more safe, and more eligible mode of ventilation than the steam jet. And with respect to the steam jet as an *auxiliary* to the furnace, the conclusion is, that the increase of the jets over the furnace is quite inconsiderable; that such increase is extremely unsteady, in some cases nothing at all, when the furnace is urged to its maximum effect, and in the ordinary working state of the furnace (supposing

the furnace kept within its limit, so as to have adequate spare power in cases of emergency), amounting to only about 2 or 2½ per cent.; that such increase is, however, attended with a loss of power or increase in the consumption of coal, as compared with the furnace, of nearly 3 to 1; and taking into account the uncertainty of its action, and that the increase of 2 to 2½ per cent. is only obtained when the furnace is about 10 per cent. within its maximum power, it is clear that the steam jet is inefficient as an *auxiliary*, when applied as a *substitute* for the furnace in the ventilation of mines." In conclusion of this subject, we give the following description of a somewhat novel application of the steam jet for the purpose of ventilating a coal mine, by Mr. F. H. Pearce, of the Bowling Ironworks:—The application is at present in operation in a pumping shaft, 120 yards in depth, the ventilation of which had been stopped by the water rising at the bottom of the pit during the time some alterations were being made in the pumps. The water having stopped the air courses, the pit, to within a few yards at the top, became full of the gas known to miners as black and choke-damp, which appears to have been discharged freely from some old workings, and thus it was rendered an impossibility for the workmen to descend until the removal of the gas had been effected, and a constant current of pure air produced in the pit. Mr. Pearce has succeeded in maintaining a perfect ventilation of the above-mentioned pit, simply by allowing a small jet of steam to issue into the atmosphere a few feet from the top of the pipes through which the water is forced up when the pumps are at work, and the pit can be worked with perfect safety. The workmen were enabled to descend 30 minutes after the steam had been turned into the pipes. The principle is exceeding simple. The jet of steam issuing from the top of the pipes produces in them a partial vacuum, which draws the foul air up these pipes, and thence out of the pit with very great velocity. The cost of applying the steam jet in the above manner is very trifling, and this method of ventilation will doubtless be found a very safe and useful one in many instances, particularly in sinking deep shafts. In addition to other advantages, wood or any other kind of pipes may be used. It requires little or no attention, no machinery to get out of repair, produces a powerful current of air, and can be regulated at pleasure. As the steam is discharged into the atmosphere above the top of the pit, it does not interfere with the men working in the shaft."

MACHINERY.—Several mechanical means of forcing air into mines, or of exhausting it out of them, have at various times been contrived, and in a few instances in this country adopted. On the continent, however, and more particularly in Belgium, where the furnace is considered to be less economical, and is forbidden by law in fire-damp collieries, and (even associated with dumb-drifts,) is being abandoned, in order to be replaced by ven-

tilators (*Mackworth's Evidence, June* 23, 1853). They are very generally applied to colliery ventilation.

Mr. John Taylor, of Tavistock, invented a form of air pump, which is thus described in Brewster's Edinburgh Encyclopedia :— " A large cistern is constructed of wooden staves, hooped with iron, circular, and from 6 to 8 feet in depth; this is nearly filled with water. Through the bottom of this vessel a pipe passes from the mine to be ventilated, and passing up through the water, is carried about a foot above it. Upon the top of this pipe is an air-tight valve, opening upwards; over this pipe and within the sides of the cistern, a cylinder of plate-iron is placed, open at the bottom but close at the top, in which top an air-tight valve is placed also opening upwards. This iron cylinder is made to move in a vertical direction by guides or sliders, and its upper end is attached to a lever or a chain, which is moved either by a water-wheel or steam-engine. An exhausting machine of this construction may be made from the smallest size to be worked by the hand, to any requisite to be moved by machinery (vol. 14, 1820).

According to a statement made by Mr. Wood, at a meeting of the North of England Institute of Mining Engineers, on June 3, 1853, a machine of Mr. Struve's invention, having an areometer, 17 feet in diameter, and worked at from $7\frac{1}{2}$ to 8 strokes per minute by a steam engine of 14 horse power, produced a ventilation of 22,000 cubic feet per minute, being $\frac{2}{2}\frac{2}{3}$ths of its calculated effect. In addition to the above, may be mentioned the centrifugal ventilation of Mr. Brunton, the pneumatic screw of M. Motte, the windmill ventilation of M. Lesoinne, the spiral ventilation of M. Pasquet, the inclined vane fan of M. Letoret, the curved vane fan of M. Combes, the feathering fan of M. Lemielle, and the pneumatic wheels of M. Faboy; the chief of which are minutely described and illustrated in Mr. Mackworth's evidence, contained in the First Report from the Select Committee of the House of Commons, on Accidents in coal mines in 1857.

The whole of these machines are liable, however, to one insurmountable objection: their liability to derangement, and the consequently unventilated state of the mine until they can be repaired. The heat of the upcast shaft of a mine, ventilated by furnace, is such as to cause a considerable circulation of air for many hours after it has been extinguished; and a proper arrangement with regard to dumb-drifts for currents which might chance to be dangerously loaded with explosive gas, will preclude the slightest risk arising from their passing into close proximity to the fire.

That air, put in motion, has momentum in common with other bodies, no one will doubt; but that its momentum in mines is almost instantaneously overcome by the friction or resistance

of the air channels, is equally true. In proof of this may be stated a fact, elicited during the application of the exhausted steam from an underground steam engine to ventilate Belmont colliery, where each stroke of the engine was distinctly observable in the workings by its effect upon the doors; and in describing the ventilation by Mr. Struve's machine (before alluded to), Mr. Wood stated that the pulsation of each stroke of the areometer piston was distinctly felt in the workings at a considerable distance from the shaft.

Art. VI.—METHOD OF EXTRACTING SULPHUR FROM ARGENTIFEROUS PYRITES. By F. Samson Thomas.

Considerable interest has lately been excited by the agitation of the question, "whether or not pyrites which are assumed to contain silver in combination with sulphur, can be economically and completely desulphurized." I am informed that various patents exist for effecting this object, but as I know that there is no recognized process now in use, I assume they are not found to be successful. I have read but one, and, therefore, am unaware whether or not I am treading on forbidden ground.

About two months ago four samples of mundic, supposed to contain considerable percentages of silver, were presented to me for the purpose of my experimenting thereon, and as I am not desirous of withholding information which may be extensively beneficial in mining matters, I herewith offer you, for publication in your Journal, the process which I adopted. I shall endeavor to describe them in a manner so full and simple, that an ordinary operator on a mine possessing such quality of ores might readily follow the experiment, and, I think, obtain success.

First, however, I may observe, it has been long known, as a principle in chemistry, that both soda and lime will, under certain applications of their properties, enter into combination with sulphur, and upon such combination being perfected, will render the sulphur soluble in water. The mode, therefore, of applying these well-known elements becomes the essential point for attention, when directed to the especial purpose of desulphurizing pyrites.

To effect this object, two distinct operations should be kept constantly in view. First, there must be obtained, by the exercise of mechanical and chemical means, the perfect cohesion or combination of the particles of soda or lime with the molecules of the sulphur, and then must follow the solution of these mixed elements in water. If these operations, first of combination, and then of solution, be not kept perfectly distinct, if the one process

be not completed before the other is commenced, or if suitable mechanical means be not employed at the proper time to assist the chemical agents, no satisfactory result can be obtained.

I am led to these remarks, by having read the one patented process to which I allude. In that, hydrate of lime is stated to be the solvent employed. It is then stated, that the lime is brought into contact with the sulphur by admixture when both are in a moistened state, such being described as a "wet paste." Under this humid application of the lime, I have no hesitation in saying that its first important influence is neutralized or destroyed; its cohesion or combination with the molecules of the sulphur has been partially or entirely destroyed; the caustic quality of the lime has been greatly reduced by the partial or entire process of slacking; and the attempt has been made to carry on the three processes of cohesion, combination, and solution at one period, which to me appears to be a violation of the laws of Nature.

The process which I have found to be successful, takes the same well-known elements (in which there is no novelty or merit, either in the patented process to which I allude or in my present remarks), but the mode of procedure becomes the all-important point upon which the merit may be claimed, or the success will depend.

The question, therefore, narrows itself into these limits—Is the decomposition or the neutralizing of the sulphur to be effected in the humid way by the hydrate of lime, or must it be accomplished by the application first of dry and caustic lime, for the sake of cohesion and combination, and subsequently by the humid process, from the simple addition of water for its solution? I believe success will be due to the latter, and for the purpose of encouraging experiments, I give you the method employed by me in detail:—

Process 1—Consists in grinding the pyrites to a tolerable degree of fineness, and washing it free from all siliceous or earthy matter. This may be done either by a dry process of grinding and after-washing, or by stamps and water; but care should be taken that the pyrites be not crushed to so fine a powder, that the atoms of silver which are in combination therewith thereby become liable to float away in the process of stamping or washing. Ordinary experience in these matters, and attention to the quality of the pyrites under treatment, will dictate the extent to which this process should be carried.

Process 2—Consists in drying the washed pyrites. This may be effected in a roaster, or on heated plates, and the effect is seen to be complete when the pyrites readily separates into finely-granulated particles.

Process 3—Consists in mixing the dried pyrites with an equal bulk of unslacked lime, finely pulverized. In this process, as also in the two following, great care should be taken to avoid all

moisture. The process should be performed under cover, upon a boarded floor, and small portions at a time only should be attempted to be mixed, and such, when well mixed, thrown into a general heap.

Process 4—Consists in grinding together the dry pyrites and the unslacked lime. The grinding should now be conducted to the fullest possible extent, and until the mass presents an impalpable powder. It is highly desirable that this operation be performed in a vessel capable of imparting from 200° to 240° of heat to the mass of pyrites and lime, whilst under the operation of grinding, as at a temperature of 224° the sulphur will begin to melt, and at 250° it begins to rise in vapor—a result to be avoided in the treatment of argentiferous pyrites. If care be taken in the foregoing points, the result will be that the heated and separated molecules of the sulphur coming into forcible contact with the atoms of the lime, pressure, friction, and heat being simultaneously applied, the affinity will be assisted, and the combination will become more perfect than it could be under other circumstances; but in the event of such a machine not being employed, the pulverizing must be completed without the addition of caloric, which it must receive in the next process.

Process 5—Must, then, consist in placing the mass of dry pyrites and unslacked lime (when finely pulverized, as before stated) in a reverberatory roaster, and roasting the same together for some time at a temperature ranging between 200° and 240°, the intention being, as before observed, that the sulphur should be softened and partially melted; but the roasting should not proceed to sublimation, nor until the sulphur rises in vapor, an effect easily known by the suffocating fumes.

Process 6—Consists in bringing the sulphur into solution. This is effected by placing the roasted mass in a boiler, and abundantly supplying it with cold water. When the ebullition caused by the evolation of the caloric has subsided, the fire should be lighted, and the mass gradually boiled, and kept at the highest possible temperature for about three hours. This process should be performed in a vessel capable of keeping the mass in continual agitation, so that the boiling water should be kept perfectly permeating the pulp, which it cannot do provided the pulverized pyrites be permitted to precipitate and lie at the bottom.

Process 7—Consists in drawing off the entire mass into a tank, and draining away the sulphurous portion from the pyrites. This is effected by having an upper and a lower tank; between the upper and lower tank should be a hatch, across which a blanket should be stretched, this will intercept any floating particles of silver; the pyrites will then be found collected in the first tank, near the outlet of the boiler; and the liquid, containing the sulphur and the lime in solution, will have passed into the second and closed tank, where it will subside into a sediment, available

for all the purposes to which that well-known compound is applicable. If it be assumed that the bulk of pyrites is not perfectly washed, this last process may be repeated, or extra washings may be conducted in the tank.

In carefully carrying out the foregoing processes, I have found that the desired effect has been obtained by the use of lime alone. I have also found that soda may be successfully employed in the same manner, or in connection with the lime, by being added in solution in the 6th process; but I believe, as I before stated, that the result cannot be obtained if the lime has been previously deprived of any of its caustic qualities, by being entirely or partially slacked, prior to its being brought into contact with the sulphur in its pulverized state. The philosophy of the matter being—and the results of my experiments justify my repeating, for the sake of impressing, the assertion—that the affinity must be first encouraged and effected in the dry state both of the sulphur and the lime, aided by a sufficient amount of caloric to cause the separation of the molecules of the sulphur, and thereby enable them, during the mechanical operation of grinding, to flow around and enter into combination with the atoms of the lime; and that, when the combination has been so effected, the subjecting of the mass to a sufficiency of water, first cold, and afterwards heated, will produce the intended object,—a perfect solution both of the lime and the sulphur.

Those who are interested in this class of ores may make the experiment; the process is simple, the machinery and vessels inexpensive, and the road, as far as the process now explained by me is concerned, unencumbered by any protective or exclusive right.

ART. VII.—PRESENT POSITION OF AUSTRALIA AND ITS GOLD MINES. *Victoria and the Australian Gold Mines in* 1857.—BY W. WESTGARTH.

THIS publication is of general interest and much use, especially at this time, when attention is directed to that rising colony by the world at large: therefore we give a series of extracts, that we may show the views and opinions of the eminently qualified writer. We begin with the all-absorbing question of *gold.* Under this head, Mr. Westgarth remarks that—Gold is found either in a merely mechanical mixture with the gravel or any soft subjacent strata into which the heavy particles may have penetrated, or it is found in the quartz rock. In the latter it occurs in two forms—one in which it is scattered through the mass of the rock, the other in which it appears in veins or masses following fissures

or lines of fracture. Nuggets or large masses are found in this latter system, and also isolated in all situations in the gravel, and throughout the drifts of what may be called the "gold measures." The spirit of mining adventure that urged on and developed the system of deep sinking, has shown the auriferous system under a new aspect. When, at a depth of 200 feet, a "lead" is struck, the practical miner searches for the "gutter;" and if he be fortunate in finding it, his hands may come back to him filled with solid gold. But the uncertainty of the lead and the expense of sinking qualify these riches materially. The gold of Victoria is remarkably pure, its fineness varying between 23 and 23½ carats—that is to say, with only from 1-24th to 1-48th part of natural alloy or impurity. The purest of the Victoria gold is that of Ballarat—a field that is both the oldest and most productive of the Victorian system. It gives a production of nearly 12,000,000*l.* sterling. Considerable quantities of gold were met with at great depths, although apparently in very uncertain localities. The practice of this deep sinking became very general, although it seemed doubtful whether, even on the average, it yielded as much as the shallower digging; but the miner was not long in recognizing a particular drift bed in these depths, in which alone was the gold commonly found. Two other minerals have been discovered in large quantity in Victoria—the rich tin ore of the black sand, and antimony ore. The value of the sand is 40*l.* per ton. The antimony ore appears to be unlimited in quantity; the value in the home market is 10*l.* per ton. The long distance from its interior location to Melbourne forms a serious drawback in the absence of railway carriage. These resources, like many others, remain for the railway era."

Population.—If we assume the present population of the colony of Victoria at 400,000 souls, they may be distributed in the following manner:—One-third are engaged upon the gold fields, one-third are at the seaport towns, and one-third comprise the interior town, agricultural, and pastoral population.

Towns.—The two great town systems of the colony are Melbourne and Geelong. Both include many outlying suburbs, extending to several miles beyond their respective boundaries, ample as these are; and we thus comprise about 130,000 colonists, of whom fully three-fourths belong to the Melbourne circle. Both of these cities (for, with reference to an early future, they may allowably be so called) are situated upon the fine estuary of Port Phillip, and both exemplify a rare rapidity of growth; the latter by the advantages of its position, and the former by these in some degree, but chiefly by its fortunate prestige as the capital of a wonderful colony. In Victoria, one capital site, if well chosen with reference to all future contingencies, would easily, from its natural and acquired advantages, have become the heart of the entire colony. But Melbourne was not the best site, as the exist

ence of Geelong, a rival capital in its near vicinity, may show. There is, consequently, a divided interest and jealous rivalry, together with a long vista of contention as to future roads, railway, and harbor improvement, that, in the difficulty of poising the even balance, may delay or defeat many useful and necessary undertakings. Queenscliffe is a very promising summer retreat for the busy traders of Melbourne. A jetty is being constructed, and if it can be so made as to permit of a passing call, going and returning, from all the steamers that now ply between Melbourne and the various surrounding colonies, we may soon realize a second Brighton or Margate. In summer the change to this place from the heat and dust of Melbourne must be delightful; the cool breeze is borne direct from the open ocean; nor can solitude be complained of where the narrow strait, as a public highway, wafts a dozen or a score of ships as the daily contribution, respectively, to the outward and inward commerce of the place. Geelong is conveniently situated as regards this pretty watering-place, and only 18 miles from it.

Ports.—As usual in colonies, the marks of progress and improvement are most conspicuous in the seaport towns, and chiefly, of course, in the capital, where all the appliances of business and the amenities of life come first to hand, whence they are scattered with increasing cost and difficulties, and in deteriorated qualities, to the other localities. Melbourne, Geelong, Portland, Belfast, and Warnambool are the seaports of chief note.

Revenue.—A surplus revenue for 1856 is already in hand. The revenue for 1857 is estimated at 3,227,930*l.* of which amount the customs alone would contribute 1,670,000*l.* The public debt of the colony did not yet amount to 2,000,000*l.*

Banks.—The note circulation of the colony now exceeded 2,000,000*l.* and the daily balance of the flourishing treasury averaged 700,000*l.* The Government, with its future borrowings for public works, might avail itself of these resources, instead of leaving them to bank proprietaries. The eyes of the treasurer are upon the profits, but not the expenses, of the official plan. Although no particulars were given, rumor already spoke of a "national bank," and "national note issue" for Victoria. Certainly the trading world are destined to a periodical pang, from the disposition of legislators and governments, to revel periodically in the affairs of banking. The proposition drew forth great variety and contradiction of public opinion; but in the main it was decidedly condemned.

Railways.—The policy of a Government proprietorship of the principal lines, and of a system of solid railway construction for a young colony, are points on which there are great differences of opinion, and upon which it can scarcely be said a public opinion has yet been proclaimed in Victoria. On this important question the colony, with its newly-assembled parliament, and

its system of free government, will ere long pronounce its views. The railway system, in this sifting of the political machinery, is likely to receive a reconsideration, which may induce the Colonial government, with its expanding cares and obligations, to alter its proposed policy of constructing and owning the main lines, and to avoid the difficulties alike of a cumbrous public debt, and of a decision upon the cheap or costly principle of construction, by leaving the whole question to the readier solution of private interests. The Government, however, on the partial failure, changed its first policy, which was favorable to the construction of private enterprise. This failure cannot affect the principle of the case. The government may at any time insure private success by affording a sufficient inducement. Besides the usual arguments for keeping the hands of government free from such sources of extravagance, corruption, and so forth, as large railway constructions, the heavy public debt with which it encumbers the state is injurious, as tending to restrict other required public works of a more strictly state character. The Melbourne and Hobson's Bay Railway came to a successful completion, although at a great cost in the times in which it was constructed. It now pays a dividend of 8 per cent., which is expected to be enlarged after the opening of the recently constructed branch to St. Kilda. The Melbourne and Williamstown Railway, which afterwards coalesced with the leading project of the day: this was the Melbourne, Mount Alexander, and Murray River Railway, which, after a languid effort of its directory, limited to the Williamstown branch line, has been transferred by purchase to the Colonial Government. The Geelong and Melbourne Railway, which has been successful, and will be completed during the present year. The Geelong, Ballarat, and North-Western Railway, which after a precarious flutter above the horizon, drooped reluctantly below it, and has not ventured to reappear since the government intimated its views on railway policy. It was difficult for Geelong to dispute the main qualities of her Ballarat line; but she had already discovered that her first railway should have been in that direction, and not to Melbourne, and she would willingly, therefore, have resumed the charge of her own interests rather than leave them to the routine rule of the Government step, and to the dubious counsels that might emanate from the rival atmosphere of Melbourne. The Direct Melbourne and Ballarat line, the great antagonist of the other, has already an ominous consideration with the General Government. The Melbourne and Hobson's Bay line, and that from Geelong to Melbourne, which is now nearly complete, are private enterprises, and will not be interfered with. Other lines may still be sanctioned, and the merits of several are now being discussed by the public—such as a suburban line connecting East Melbourne with Richmond, Prahran, St. Kilda, and Brigh-

ton; and a line to connect Melbourne and Geelong with the promising watering-place of Queenscliffe (the projected Queenscliffe and Geelong), on the western headland of the entrance of Port Phillip. There are well-known cycles of enterprise connected with the home money market, during which every feasible railway scheme of Victoria would be readily taken up and carried through, as has been done in so many other places, without any trouble to government, or any very oppressive guarantees being called for. Such seasons were those of 1844 and 1845. If another such era, sweeping onwards, should find the Victorian government, still toiling with its single hand through the great railway necessities of the country, and their interposing between the colony and the general enterprise that seeks it from without, Victoria will be in danger of missing a position that ten or twenty years of subsequent exertion may scarcely make good to her.

Immigration.—The immigration question has been so far illustrated in its fresh bearings under the new political system. At a large public meeting in Melbourne, where the industrial classes were in strong muster, a condemnation was pronounced upon the old practice of the importation of labor at the public cost. The meeting is reported to have been an effective one.

Imports.—The value of imports for 1856, of which I have not the completed returns, is computed at upwards of £14,115 000.

Exports.—These tables furnish a concise, but effective, picture of Anglo-Saxon development. A very sanguine temperament in surveying the past might be left without restraint to expatiate in the future. Many of us have already grown up from the child to the man upon our new colonial home; but the young Victoria has outgrown us all: 1856, commerce, £16,000,000; gold, £12,014,224: total, £28,014,224.

Wool.—The increase of British wool importation is one of the pleasant marvels of modern commerce. The comparative handful imported in the year 1817 has become the ninety millions of 1857; and the Australian contribution, which was long a blank upon the earlier pages, now considerably outweighs the collective quantity of the rest of the world. Exports of wool from Victoria 1855, 22,353,000 lbs.

Hides.—There is an extending trade in the exports of hides; colonial hides now rank high in the home market, being equal to, or even beyond, those of Buenos Ayres. They are worth at present from 15s. to 18s. each in the colony, and the value of the annual export is about £30,000.

Climate.—As Victoria lies between the degrees of 35 and 39 of south latitude, it is unnecessary to remark that the ample areas of its cultivable soil are suited to yield all the cereals of central and temperate Europe. It corresponds to Southern France and the northern parts of Spain and Italy.

Shipping.—Hobson's Bay, Port Phillip: Around us were many of the finest ships to be seen in any harbor, varying from 1000 to 3000 tons in dimensions. About three years ago, 600 square-rigged vessels are said to have claimed attendance at one time. It is ominous of the future that the harbor master has been already communicated with on the subject of bringing up the *Great Eastern*, and has promised to steer this mammoth boat, with her 10,000 souls, by the South Channel, in Port Phillip Bay, in safety to her anchorage off Williamstown, in Hobson's Bay.

There are some slight omissions and errors in this work. No mention, for instance, is made of the production of copper ore, which other colonial writers affirm to exist in large quantities, and to be quite equal to the Burra Burra, of South Australia. Plumbago, lead ore, and platina, are likewise without mention, although they are alleged to exist in the colony. Again, Mr. Westgarth is silent as to coal, which the government reports describe as being found in various places near Melbourne and Geelong.

Art. VIII.—SALT—HISTORICALLY, STATISTICALLY, AND ECONOMICALLY.—NEW AND IMPROVED AMERICAN SALT MANUFACTURE.* By Professor R. Thomassy.

1. *Progressive Ascendency of Foreign Salt in America—its Distribution throughout the United States—Legitimate Pride of the British Salt Traders, their untiring zeal to be Imitated by American Consumers—a coming Revolution in Salt Manufacturing.*—The imports of foreign salt into the United States is increasing yearly with a wonderful progression. It is carried on, not as in the old colonial times, by some hundred sacks of this article, but by thousands and ten thousands of sacks and tons, landed every week on the American wharves; so that every year, one, two, three or more millions of bushels are imported, as if it was to prevent the competition of a domestic manufacture by the superabundance of foreign merchandise. But the United States are the greatest consumers of salt in the world; more than one bushel to each inhabitant is the average of their individual consumption; when in Europe, the same average does not reach a half bushel. Hence, the repeal by the Congress of the old duty on the foreign salt, and the welcome given to any new cargo of this vital article. See the reports of the United States Treasury: during the year 1854–'55, this importation of salt was about 13 millions of bushels, and during 1855–'56, it has been 15,405,864 bushels! Now wait for the next report of 1856–'57, and the new statement

* From De Bow's Review.

will reach probably 17 millions of bushels, costing, with the freight, at least $3,000,000—a yearly tribute paid by American consumers, and worth, undoubtedly, some consideration.

As to the main quarters of this supply, during the said year. 1855–'56, they were as follows:—

	Bushels.
Boston imported	1,985,278
New York "	3,380,486
Philadelphia "	1,107,888
Baltimore "	960,370
Charleston "	858,328
Savannah "	885,781
Mobile "	923,182
New Orleans "	3,338,394

And so on in other places. So that the total importation causes a waste of at least three millions of dollars, which certainly would be better applied to internal improvements and cultivation of the Southern sea-coasts.

In this general statement the special import of British salt is still more prodigious; being, for 1855–'56, 12 millions of bushels or the four-fifths of the whole importation. Such a gigantic trade looks truly like a pacific invasion, a silent and sure conquest of the American market by an article of paramount necessity, not only for human life, but also for agricultural and industrial purposes, for manuring the cotton fields, for curing provisions and fisheries, or for chemical products. All these leading industries, all these national resources of the United States, it is impossible to deny it, are, in their selling price, ruled by English salt; and British pride must certainly be satisfied in seeing the master of this prime matter enjoying in the New World, so large influence over any pursuit where this vital article is called for.

When I visited Liverpool, the distributing centre of this mighty trade, I understood clearly, after visiting some of the most extensive salt works in Cheshire county, how salt, as well as iron and coal, has enhanced the British influence throughout the world. English statistics, though incomplete, by lack of official documents, have recently given us some general notions showing with how gigantic stride their domestic salt manufacture has been lately extended. "During the last year, (1855,") says the European Times of Liverpool, only speaking of Winsford district, "130,000 tons of this salt was exported to the United States of America; and in the last ten months the salt sent to the same country increased to 274,000 tons—(10,960,000 bushels, or more than 13,000,000 for the whole year 1856). The quantity shipped in the same time to British North America, Africa, Australia, and the East Indies, amounted to 274,268 tons. The export to the Baltic was 34,000 tons; coastwise, 100,000 tons; and for

home consumption, 120,000 tons. The total yield for the last ten months has been about 800,000 tons;" or for the whole year nearly 1,000,000 of tons, or 40,000,000 bushels. Now to this production we must add that of Northwich, and some other places, equal to three-fourths of the preceding, and we can value and admire how this most stupendous manufacture divides its products between the national and foreign markets, yielding 20,000,000 bushels for home consumption, and 50,000,000 for supplying the remotest parts of the world, to the profit and honor of the exporting nation.

Thirty thousand English mariners are carrying abroad, through all the seas, this paramount merchandise, when at home a laboring population, at least equal in number, depends directly for a living on its domestic production. On it, of course, an immense amount of capital is invested, and from it the most valuable benefits and social improvements are derived for the internal welfare of England. For instance, the cheapness of salt, 3 or 6 cents per bushel, causes its rapid and profitable consumption in agricultural as in industrial pursuits. The same low price created in France fifty years ago, and is now increasing daily in England, the powerful manufacture of chemical products, which has given so great impetus to the progress of material civilization. Near Liverpool, Newcastle-on-Tyne, and Glasgow, are gigantic establishments where millions of bushels of common salt are yearly decomposed by the use of sulphuric acid, and used to make immense quantities of soda-ash, bleaching powder, and various similar articles, required for the health or comfort of the great human family. The United States are once more the largest importers of these valuable British merchandises, paying for them three other millions of dollars, and acting in this new trade of prime importance as a mere country of consumers, unable to supply their own wants. Meanwhile the English chemical works, thanks to the low price of their domestic salt, are yearly increasing in value and productiveness, and for their magnitude, the perfection of the details, the consummate scientific skill of their management, are worthy to take place among the wonders of Great Britain.

England, of course, in this stupendous production and trade of salt, has availed herself of her peculiar situation. All her salt being made by artificial evaporation with iron boilers and fuel, though of the worse quality, is perfectly adapted to a country where the richest salt wells and saliferous strata, are, by navigable rivers and railroads, in direct communication with the Lancashire coal mines. Having the cheapest fuel for evaporating the strongest brine, she manufactures a bushel of salt for three or four cents, and with another trifling expense she sends it to Liverpool, of which the immediate vicinity and cosmopolite navigation admits at the cheapest freight. The fortunate connection

of this shipping place with the salt works, and of the salt works with the coal fields, has caused the artificial superiority of English salt traders and manufacturers. But in spite of their skill, nature is still living, and nature works against them. Her evaporating power, refused to the wet and sunless clime of Great Britain, is a gratuitous salt-maker for any more southern country, for France, Italy, Spain,-and consequently for the South of the American Union. Then gratuitous as the agency of the sun and winds, and inexhaustible as the brine given by the ocean, the natural evaporation must sooner or later supersede in salt-making the British fuel, and triumphantly compete against it in the United States as well as in southern Europe.

England, herself, is perfectly aware of this change, and of this inevitable revolution; and she tries also to control better the evaporating forces of southern climates in her West Indies, as in the Bahamas and at Turk's Island. There, nature alone has, till now, effected entirely the salt-making. But already practical skill is called for. Turk's Island, for instance, not long ago, was a poor dependency of the Bahamas. By extending their natural salt ponds, and building new salt works, imitated from the old French method of making salt in St. Domingo, these barren places are become a British presidency, yielding nearly one million and a half of bushels, to the great profit of the population, and treasury of the Crown. Inagua is another British place rivalling the former in the same production, waiting for more complete improvements, and giving us a new standard of the English far-seeing policy.

A new era is coming for manufacturing the vital merchandise by a cheaper method. Any natural power, better understood, brings forth human progress. Therefore, America, availing herself of the atmospheric evaporation, will soon produce all her own salt, and enfranchise her inhabitants from any tribute paid for this supply to the old world. Like the star of empires, the progress of salt works, once more, is now westward. Small, bright, but infallible harbinger of the greatest revolution.

After the fall of the Roman Empire, of which the commercial power was built at first on the Etrusian salt works of Ostia, Venice took the lead of the same policy, and became the most skilful salt trader of the middle age in the Mediterranean market, when the old Federative France was carrying and monopolizing the merchandise to the northern seas. Then Oleron Island and the renowned *La Rochelle* were supplying England, who, when allied to the French Huguenots, was taking care of her salt trade and consumption as much as of her Protestant co-religionists. At last England enfranchised her own population from the foreign supply, and became what she is now, the greatest salt trader of the world. But America waits for her turn, welcoming every new morning the mighty power of the sun, of which the

gratuitous evaporation, united to the forces of her sea breezes, is now to supersede easily the costly management of English boilers and fuel, and to save the pricc of trans-atlantic transport in making salt everywhere at hand for any kind of domestic consumption.

2d. *Historical and Political Influence of the Mastery of Salt—Spirit of the Revolutionary War as Regards the American Salt Manufacture—Striking Example of the same Spirit in the History of South Carolina.*—To understand better how much the actual dependence on a foreign supply of salt can be injurious to the United States, we have first to examine the general influence of salt upon internal relations, and to know its unsuspected weight in the balance of power. Historical testimony is unanimous upon this subject, and the experience of mankind will be also corroborated by the double trial of the United States in the year of their political independence, and during the second war with the mother country.

At every period in the history of the world, with every advance of civilization, what do we see? The people who have abandoned to foreign nations the supply of salt, chastised, sooner or later, for their carelessness. From tribe to tribe, as from people to people, the control of this vital article has always given some ascendency, and often an inevitable dominion, for the manufacturer of salt controls always, in some respects, the health and social well-doing of the people obliged to buy it. Who rules, indeed, the Chinese population, if not the Tartar race, who, after their first intercourse with China as salt traders, became at last the conquerors of this Empire? Thanks are due by these barbarians to the salt lakes and fossil salt so abundant in their wildernesses, by the use of which they continue their primitive trade; and loading with salt innumerable camels, take, in return, the thread, linen, and millet of China; they bring back also with them the obedience of their consumers, because salt is the most necessary article in all these exchanges.

Look at the negro race in Africa. Who are their rulers, if not the Arabs and Moors, masters of inexhaustible salt lakes and mines, whilst the poor Nigritian is absolutely deprived of salt in the interior of his deserts? Singular exception to the laws of Providence, who, after lavishing this vital element throughout the world, has refused it to the sons of Ham. Hence the manifestation of a new social law, which has established the most serious and instructive intercourse between the tropical and northern population of Africa. The want of salt on the one side, and the superabundance of it on the other, have brought nearer, as in Asia, in spite of sickly and impenetrable solitudes, the most diversified races, one born to rule, and the other to obey. Of such a relation the result was almost inevitable. The superior race uses and abuses its natural advantages; and as necessity is

superior to utility, as life prevails over luxury and well being, the master of this vital merchandise rules the market. Receiving in return the gold dust and ivory from the Nigritian, the Arabs and Moors often carry away the negro himself—obliged to give up his liberty because nature has made him dependent on a foreign supply of salt.

The English dominion in the East Indies produced in the last century an analogous social phenomenon, when the merciless Warren Hastings established his exclusive and dreadful monopoly of salt. The timorous Asiatic at this very time gives his English ruler the title of "Master of the Salt," showing by this qualification that salt is regarded by them as the infallible index of power and true privilege of conquest.

Such being the influential trade and production of salt, what ought to be done by so free, strong, and far-seeing a people as the Americans, if not to manufacture all the quantity that they consume at first, and afterward exchange the residue with inferior races or foreign countries? But how short is the indigenous production from the present consumption in the United States. Instead of producing all their salt, they are importing yearly sixteen millions of bushels, and especially all the sea salt wanted for their provisions and northern fisheries.

We must even confess it frankly: young America, confident in a dream of perpetual peace, as much perhaps as in the productive strength for every kind of wealth, does not inquire about her consumption of salt, either foreign or domestic. Very well! Let, if you will, the greatest part of this vital element remain in the hands of the mother country, and believe in her *entente cordiale!* But remember also the heroic trial of your independence, and the want and deficiency of salt during your second war against your old dominators. Keep well the records yet living on the Atlantic shores and teaching us the distress of those hard times, when your people were flocking from the Alleghany mountains to the sea coast, to make, at heavy cost, bad salt, and in limited quantity, from the ocean brine. This is worth your remembrance.

The history of the Southern States will enlighten particularly the matter put before us, and recommend itself as a testimony of general experience to be repeated. Clear, precise, and conclusive experience, which exceeds all others as the most mournful summary and faithful expression of the great drama of American liberty! At this crisis so imperious in regard to the supply of provisions of prime necessity, gunpowder and salt were equally wanted, and it was urgent to manufacture them both, as the double means of life and victory. European governments, jealous of keeping their colonies under perpetual vassalage, were also very well acquainted with the fiscal importance of the salt they were manufacturing at the lowest price, and supplying at the highest. The absolute monopoly of this article has been always

the aim of their policy, and it was the most avaricious regulation of old England toward her colonial dependencies. Look now at the colonies when the English salt, the only salt used for their food, and of immediate necessity, rapidly diminished. A tremendous scarcity of the vital element appeared in the market, and no domestic production was ready to counteract it. Under such unforeseen circumstances, lawgivers, the very best friends of liberty and economical principle, were obliged to fix a maximum price on salt and to regulate its sale, doing what in a normal situation would have been the most anti-economical, anti-liberal. Later, in France, under similar but more tragical circumstances, the National Convention tried also, by a *maximum* price, to counteract the scarcity of 1793; but in France, also, the evil increased by the remedy itself: so that the American *maximum* of 1776 can be now better understood, and will be remembered.

Let us read in the resolutions of the provincial Congress of South Carolina, March, 1776, the full testimony of this great experience.

"Whereas, information hath been laid before the Congress that certain persons do monopolize the necessary article of salt, and demand an extravagant price for the same; and also require specie in payment, to the detriment of the continental and colonial currency; the Congress do therefore

"*Resolve*, That no person do hereafter presume to sell salt for more than twenty-five shillings per bushel, (about $6 25,) exclusive of the expense of reasonable freight or carriage to the distant part of the colony. And that Mr. Jos. Kershaw, Mr. Loocock, Mr. Samuel Prioleau, junior, Captain Maurice Simons, and Capt. Samuel Legare, for Charlestown; Mr. Daniel DeSaussure, and Mr. Thomas Hughes, for Beaufort; and Mr. George Croft and Mr. Antony Bonneau, for Georgetown, be and they are hereby appointed Commissioners, and empowered to inquire after, and buy up, out of the hands of individuals, all quantity of salt which such individuals may have more than necessary for their respective families, and to dispose of the same in small quantities at the same rate. And that the said Commissioners do also purchase all the salt which may be imported within six months.

"That Col. Laurens, Mr. Ferguson, the Rev. Mr. Tennent, Mr. Edwards, and Mr. Gibbes, be and they are hereby appointed Commissioners to erect and superintend a *Public Salt Works* at or near Charlestown; that Mr. Joseph Allston, Captain William Allston, Mr. Benjamin Young, Mr. Peter Simons, and Mr. Thomas Butler, be and they are in like manner appointed Commissioners for a *Public Salt Works* on the Northern coast; and that Captain Thomas Tucker, Mr. Daniel Jenkins, Mr. Joseph Fickling, be and they are hereby appointed Commissioners in like manner for a *Public Salt Works* on the Southern coast of this colony. That each board of the said Commissioners, respectively, shall have

power to draw upon the colony treasury for any sum not exceeding ($35,000) seven thousand pounds currency, for defraying the necessary expenses incurred by this service. And that they shall sell the salt, to be made at the same public works, at the most reasonable rate." * (19 March, 1776.)

In every one of these Commissioners, I am happy to recognize the names of my countrymen, the French Huguenots, who originated from the provinces of France the most advanced in the salt manufacture; practical and enthusiastic people, who, giving their arms and skill to the industrial emancipation of the New World, dedicated their hearts and hands to the conquest of religious and political freedom. Remember, also, that after the revocation of the edict of Nantes, they brought to England the French method of making salt from the sea brine by atmospheric evaporation. But under the sunless and damp skies of England this method was, of course, unavailable, and was given up in the beginning of this century.

In relation to the public spirit of these times, South Carolina evinced a standard of it in the matter of salt, acting with wisdom, foresight and energy, as the duties of that heroic age required. We should neither forget the warm appeal made to Dr. David Ramsay, from Philadelphia, for introducing in Charleston, *by examples and writings*, the improvements of the nitre manufacture, (14th March, 1776.) Iron-work, paper mills, internal canalization, societies incorporated for the promotion of agriculture, were, at this same time, matters of the highest importance for the Carolinian lawgivers. In short, they were ready to advance money to the most enterprising citizens, and encourage every useful industry, introduced with the express purpose of being carried on *in as great perfection as in any part of Europe.*† In this simple expression, what pride! Those who spoke in such a manner were very truly disenthralled from the old world by this resolution of being equal to any civilized people. They certainly were no longer politically bound to their European mother country; and when the time arrived, would be no more dependent on her for the future supply of salt, as well as gunpowder, and other articles of national importance.

This patriotic and provident conduct was followed with emulation by Georgia, the younger sister of South Carolina, and by the other States of the rising confederation, each of them understanding that, without an indigenous and independent production of vital merchandise, their political independence was jeopardized.

* To complete this important regulation, two days after it, the Congress adjoined Mr. Benjamin Eddings to the commission intrusted for erecting Salt Works on the Southern coast. (Page 116, Provincial Congress, 1776.)

† 23d March, 1776.—The Provincial Congress * * * *Resolved*, That the sum of three hundred pounds currency be advanced to the said Wm. Bellamy * * * for the express purpose of his forthwith erecting a proper mill for making paper, and cutting files, in as great perfection as in any part of Europe.

A glorious peace crowned at last those efforts, noble in industry as well as in war; and this paramount result afforded, undoubtedly, the most practical, if not the brightest event, which characterized the Revolutionary war; it was that steady ambition spoken of for Americanizing all necessary articles of consumption, and carrying on the domestic manufacture *in as great perfection as in any part of Europe.* With this constant aim for internal improvements, all fears, indeed, were vanished; for the fruits of the conquered liberty were ripening over an indigenous tree, and the supplies gathered by the peace were always at hand to prevent any famine from a future war. Thus all emergencies, at home or abroad, were controlled, and the strongest lie given for ever to the old monopolies of the British aristocracy or other European governments. In economical as much as in political respect, the new American confederation boasted rightly to be independent; the South particularly felt herself, at that time, far-seeing and wide awake on the national advantages of any domestic manufacturing, and gave her sons the experience of the past as the true standard of the future. Such was the first spirit of the Revolution, nowhere better embodied, nowhere printed in more striking characters, than in the history of South Carolina. But too soon this cautious policy was forgotten during the unbounded enjoyment of the victorious emancipation; and how much that carelessness in matter of salt production has been once more injurious to the American industry and agriculture, particularly to the cotton production, we must now recollect.

III.

New attempts during the war of 1812, *for domestic salt manufacture —The old American process compared with the French-Indian method of making sea salt.—Advantages of this new method as applied to the Southern States.*

The main trial of American industry during the second war of 1812 to 1814, was once more to manufacture its own salt. When the foreign supply of that article—of which everybody wants so little but wants absolutely—was stopped, one could have seen the results of a new famine: as during the war of Independence, each fireside was inquiring for the vital merchandise, and the whole country anxious for her interior life, a true revolution took place in the housekeeping of young America, as would now befall the laboring classes of old England were they bereaved of our cotton. Salt being called for at any cost, every one was trying the best way to get it, bringing his tools to the sea-shore or a salt spring, and by boilers and fuel producing the article for his private supply or for the public market, where it was wanted more and more. Thus the manufacture and trade of this imperious merchandise became the greatest domestic business of the

moment. Meanwhile, the Federal Government was quietly taking care of the salt springs and saliferous fields; and American lawgivers through all the country, were patronizing any salt-making as the most urgent of the public interests for the internal welfare.

The old salt works, established in 1776 by the legislatures of several States, were carried on anew in South Carolina, near Charleston, Beaufort, and Georgetown; in Virginia and Maryland, on the shores of Chesapeake Bay. Private producers undertook, in Georgia and elsewhere, to supply the same article. In short, from Massachusetts to Florida and Louisiana, a thousand spots on the Gulf and Atlantic coasts were hastily covered by similar small etablishments—a curious symptom of a national industry rising again to life, under the pressure of exterior events.

The first experiment of the Revolutionary war being almost forgotten, this second trial was carried on without any more practical skill. The most elementary notions of this manufacture being misunderstood, were applied in two ways, each equally slow and expensive, but, nevertheless, worthy of recollection for the warning of future American producers. One was an imitation of the old working of salt springs in England, by artificial heat and iron boilers. The sea brine was introduced in the boilers by wind or tide mills, and evaporated with the fuel of neighboring forests till the salt crystallized. The striking defect of this process was in assimilating two brines of the most different strength; the sea brine containing never more than four per cent. of salt; the brine from salt springs having often from ten to eighteen per cent., that is three, four, or five times greater quantity of crystallizable matter. Every one knows that this crystallization begins when the brine is concentrated about to 25°. Thus, salt springs of 18°, for instance, require, to produce their salt, only 7° more; but sea water of 4° wants 21°, and, for its full concentration, requires as much relative fuel and expense of management. Such was the backwarded process of making salt, from the sea brine, by artificial heat, without applying, to concentrate the same, the paramount and gratuitous evaporation of the sun and winds.

The result of this natural evaporation, so frequently seen on the sea-shore, gave the idea of the second process, an excellent idea, but so badly applied that, as it will be proved afterward, *three-fourths* of the evaporating force were lost, as they are lost even now in the renowned salt-works of Syracuse. According to this second method, sea water was, by artificial means, lifted up in wide wooden vats, so disposed as to receive in the highest vat the weakest brine. From this depository, the brine, some little evaporated and cleaned, was, through wooden pipes, carried from one vat to the other down to the lowest, where salt, at last crystallized, was gathered in a solid form. To shelter this graduation of brine from the injury of rain, wooden and movable covers

were always at hand, ready to be rolled over all these vats, or, hanging double on a pivot, to protect from the rain or expose to the sun two vats at the same time.

Twenty years ago these double covers, as used on Nantucket Island and many Northern places, were employed near Charleston, on Morris Island, where Mr. Kershaw, working his negroes when idle in summer time, once produced some thousand bushels of salt yearly. The producing expenses of the article were fifty to sixty cents a bushel by this last process; but the average price of the two methods was a great deal higher—at least one dollar. In both cases, so long as the salt was wanted at any cost, no producer could complain of the expensive manufacture of the article, its selling price being profitable. Transporters took also their profits, sometimes monopolizing the merchandise with the retailers; thus consumers of every class, compelled by necessity, paid per bushel what was asked, three, four, and even six dollars; as much as under the old despotism, when salt, iron, gunpowder, and every vital article, was forwarded to the thirteen Colonies by English monopolists.

To understand better this period in the economical history of the United States, we must remember that, from the general embargo of 1808, privations of customary merchandise, as David Ramsay tells us, put the public mind in the most impressible state. Warm addresses to the people awoke easily the revolutionary spirit favorable to manufactures. But the people needed also technical information and traditional experience. Nothing was any more ready than in 1776, for securing the practical success of necessary innovations. Of course the new salt works erected on the Atlantic coast, did not counteract the scarcity which lasted as long as the war. A document from North Carolina, printed afterward by the Senate at Washington, gives us an important testimony on the burdensome price, bad quality, and insufficiency of merchandise at that time, when salt was required in the smallest quantity, merely for health and life, and not as yet for agricultural and industrial purposes by cotton planters in the South, farmers in the West, and fishermen in the North.

"During our Revolutionary war, when our ports were closed against accustomed supplies, our necessities compelled us, along our seaboard, to the manufacturing of boiled salt, against which we are now contending; the inhabitants of the State generally flocked here, erected their temporary boilers, and returned home with their commodity, generally inadequate to their wants, and at all times vitiated and unfit. Their provisions suffered, as might have been expected, and an unjust odium has been entailed upon all salt of domestic origin. Subsequently, when the scarcity excited by the last war suggested the idea of our present improved process upon a large sale, it may have happened that a *want of practical skill*, and the incessant and insatiable demand

upon our works, might have rendered our vat salt short of its existing purity. But now, that experience has furnished its lights, and it is made superior in efficacy (as is admitted by all accustomed to its use,) *is it not folly, is it not madness, to send our funds abroad, when they might be expended among ourselves?*"

This last remark from Mr. John R. Loudon, of North Carolina, was as sensible as patriotic, and evinces a true understanding of the financial importance of the subject.

As to the management of the same salt works, after the second peace between the United States and England, the improvement spoken of consisted only in their permanence on a larger scale along the Atlantic coast, whether built with iron boilers or wooden vats. But the manufacture itself was not at all improved by the double process applied to the concentration of sea water. The slow concentration of such a weak brine in both methods, made, as we have seen, the trial too expensive; and of course, when, in later time, unprotected by the home tariff, this domestic production became unavailable against foreign competition.

During this second period, American salt springs were almost unknown, or worked so badly that very little, and a very bad article, was gathered from them. Hence another cause of scarcity for the inhabitants of the western ranges of the Alleghany mountains. At last, in those regions, stronger saliferous strata were discovered by means of artesian wells; and more salted waters became so productive, that, from the west of Virginia, Pennsylvania, and New York States, their products were sent toward the Atlantic coast, and, competing with superiority against the domestic sea salt, accelerated the abandonment of its backward manufacture.

The history of these salt springs and of their exploitation* progressing with the number of inhabitants, will be afterwards an interesting one, particularly as to the application to their brine of our method of making sea salt by atmospheric evaporation. Let this only be known at present, that they are supplying nearly two-fifths of the United States; and though unfit for provisions and fisheries, still their production prevents the foreign salt from ruling the northwestern market. Salt springs are also abundant in many of the Southern States, but, generally, under circumstances very unfavorable to the transportation of their products.

At this moment, let us prefer the sea water, lifted up by high tides upon convenient places of the Atlantic shores. In order to call the attention of enterprising citizens to the cheapest and most

* This French word "exploitation" seems worth an introduction into the American language. Its meaning is very comprehensive; for the working of the salt establishment, its management, and all the technical and commercial operations connected with it, are expressed by this single word.

improved method of making salt, let us show some financial results of this industry, and how far superior it is to the past or present method practised in the United States. The Salt Works of Syracuse, in New York State, are the most extensive and noticeable in the New World. There 6,000,000 bushels and more are yearly manufactured; 5,000,000 by boilers, and about 1,000,000 by solar evaporation.

When I went, near the close of 1854, to visit this splendid laboratory of human skill, I asked the producing price of the article. "It varies, in some places ten or twelve cents a bushel; in others seven or eight." "Very well, I will take, as your standard, the *minimum* price, seven cents. Now, as it would take too long to give you my secret, I prefer to reason with your official reports. In the last report of 1854, (page 14,) Professor Cook, appointed by Syracuse itself, tells you that *about three fourths of the evaporating power is lost in the actual process of making salt.* Then you will understand that, by controlling all the evaporating force of the sun and winds, you could have, as we have in the south of France, three times more salt than is now made in your wooden vats; or, the same quantity three times cheaper. Indeed, for the last twenty years, the French sea salt, per 100 kilogrammes of 232 pounds, (4 bushels,) costs 8 or 9 cents, or about two cents per bushel. This fact is of public notoriety. By some new improvements in salt works which I introduced in Italy, in 1848, I have produced the bushel for only one and a half per cent, from the brine of the Adriatic sea, which is six times weaker than yours; for it has only two and a half per cent. of salt, while yours has sixteen or eighteen per cent. Thus, in Syracuse, in spite of the richness of the brine, the cost to the manufacturer, per bushel, is seven cents, when in France and Italy it is only two cents. Why so incredible a difference? Read once more the report of Professor Cook: they lose three-fourths of their solar evaporation." *

Now, every one understands that, with a method producing three times more salt, or the same quantity three times cheaper, we can easily produce, not only in Syracuse, but all along the Atlantic shores, under the bright and glorious sun of the South, the bushel of salt for about two cents, instead of seven or a great deal more.

With a diminution of five cents per bushel, the total saving on six millions bushels manufactured in Syracuse, would be yearly $300,000. But we have to apply this calculation to the selling price of foreign salt, exclusively consumed in the Southern States. I take twenty-two cents as the average price of this salt, and suppose the American production ready at two cents

* See on the same subject, my article published in the Albany (N. Y.) Evening Journal, 3d January, 1855, and in DeBow's Review.

per bushel, to compete against it, with an economic superiority of twenty cents. What will be the result upon 17,000,000 bushels imported yearly into the United States? A total saving of $3,400,000—a handsome sum to be saved and invested in internal improvements.

As to South Carolina and Georgia, which are now consuming near 2,000,000 bushels of Liverpool salt, their yearly saving, by a domestic supply of the article, will be about $400,000. A large and direct profit will, at the same time, derive to them from their new salt works near Charleston, or the entrance of Savannah river; for the merchandise made from the sea brine, and by natural evaporation, has always taken the lead of the market as the best kind of salt for curing beef, pork, cheese, and other provisions, which constitute the wealth of the western farmers. The State of Tennessee will be certainly supplied in this way with the Atlantic salt from Georgia or South Carolina, instead of the Turk's Island salt, carried from New Orleans up the Mississippi river. New Orleans herself, which, in the financial year of 1856–'57, has imported nearly 4,000,000 of bushels, will retain, by a domestic manufacture of the article, all the profits of the foreign producers, and will increase yearly the wealth of Louisiana, Texas, and Mississippi, by saving an importing sum of about $800,000.

But these advantages are not to be compared to that of having indefinite quantities of salt at hand for agricultural purposes.

For manuring the cotton field, for instance, how many millions of bushels could be sold at four or five cents, as it is in France or Italy. To supply that unlimited quantity wanted by old and new planters, how many thousand acres of sickly and marshy land would be turned into healthy, evaporating fields, and rich crystallizing rooms, depositories of this vital article, now unrivalled by the cheapness of its production.

But before entering more intimately into the peculiar improvements derivable to the South from such a domestic manufacture, let us look at the greatness of its result to the Union at large.

(To be Continued.)

Art. IX. CHANCELLORSVILLE GOLD AND SILVER ORE REDUCTION COMPANY.

The works of the Chancellorsville Gold and Silver Ore Reduction Company at Frodsham, in England, are the first that have been erected in that country, for the purpose of practically and scientifically endeavoring to secure a successful commercial result

from crushing and reducing quartz, &c. The company possesses a quartz mine 24 miles from Fredericksburgh, in Virginia, United States. The quartz is there regularly worked out of a lode; and although the supply received has hitherto been good, it is expected to be considerable larger, as the staff in Virginia has recently been improved and strengthened. But this mine is by no means the only source to which the company confidently looks for the supply of its raw material. Wales will contribute very largely; for already offers of 10,000 tons of quartz a month have been received from the owners of works near Dolgelly, Merionethshire; and the Welsh material is stated to be equally rich in gold as the Virginian, from which it is said the average hitherto obtained has been about an ounce and a-half per ton. Australia, too, is at the service of the company, through the owners of one of the lines of clipper vessels, who have promised at once to begin with a small monthly supply, to be hereafter increased. The Virginia quartz is brought to this country (Liverpool) by American traders as ballast; and it is said that it can be deposited on the company's wharf at Frodsham, at an average cost of £1 10s. per ton. The Australian clippers will also bring quartz as ballast; and the supply from Wales is estimated to cost £1 per ton.

Two or three considerations, all of them important, have influenced the company in the selection of Frodsham as the site for their operations. The works are on the navigable river Weaver, about a mile and a half from its junction with the Mersey, at Weston Point; there is sixteen feet of water alongside the wharf, at high tide; and so, barges loaded from vessels at Liverpool, can proceed direct to the works. Then, Liverpool, with which there is this easy and cheap water communication, has by far the largest share of the American and Australian trade; so that the chances are supposed to be four or five to one, of vessels ballasting with quartz for that port, over any other port in the United Kingdom. The works are almost close to the bridge which carries the Birkenhead, Lancashire, and Cheshire Junction Railway over the Weaver, and which forms part of the viaduct across the Weaver Valley; the distance from the Frodsham Station but little exceeds a mile; and the company's lease of their premises and land (3½ acres) gives them the power of constructing a tramway from the railway. Coal can be obtained very readily and cheaply—a most important consideration, seeing that a ton is needed for the reduction of each ton of quartz; and there are close at hand in the valley, chemical works from which the required acids can be procured.

The company's *modus operandi* includes a good many processes. Our object will be to describe them as briefly and popularly as possible. The quartz, broken to about the size of half-bricks, is roasted or calcined in an ordinary kiln, upon an average for four hours. At present, ten per cent. of the contained sulphur is lost,

from the simple construction of the kiln, but the quartz is made so friable by this preliminary operation, that an estimated saving of 5s. per ton in the subsequent processes results. The kiln will be improved, so as to save the sulphur; of which the Chancellorsville (Virginia) quartz contains 15 per cent., and the Welsh from 20 to 40 per cent. In the first calcination, only cinders are used—about two cwt. per ton.—The second process is performed by an ordinary Cornish stamper of 12 heads, each of 7 cwt., with 9 inch fall, the engine making twelve revolutions a minute. The stamper is supplied with a stream of water from the neighboring hills; and by it the pounded quartz is washed through sieves into a series of film-beds. The result is to cause almost every particle of matter to be deposited at the bottom of the beds; the water flowing from the last, nearly as clear as when it enters the stamper. The third process is with the sandy, muddy-seeming mass collected from these beds. There is a shaking table and a triturating "devil." The latter is a perforated cylinder, revolving easily on its axle; and as it is fed, it rejects the coarser and grosser particles, but allows the finer and heavier to fall upon the table, over which water flows. The result of the combination of the trituration, flooding, and shaking, is that the finer, but heavier, metallic particles are retained upon the upper portion of the table; while the mass, as it progresses to the lower end, gradually resolves itself into silica with scarcely the slightest admixture of metal, and pure granulated silica, which is constantly jerked from the table to a pit below. The shaking table is kept in operation for a period dependent on the judgment of the superintendent; but the matter at the upper end is frequently stirred. Whenever necessary, what remains upon the upper third of the table is removed to await the new process; the rest is at once rejected, or subjected to renewed trituration and shaking, as may be decided after an examination. A considerable portion of the matter kept is metallic, there being present, in addition to gold, traces of silver, some iron, copper, mundic, &c. The next process is conducted in another part of the premises, all the preceding ones being carried on in the open air. The reserved matter is placed in a reverberatory furnace, of which there are two pairs; and it is there kept at or near white heat for about four hours. From the furnaces there run brick flues, in all 60 ft. long, and containing 9 in. of water. The vapor must pass over the water; and in it any contained sulphur is deposited in the form of flour of brimstone, for the removal of which the flues are tapped. Before the "charge" is drawn from any of the furnaces, all the flues are closed, so that nothing of value can be carried off; and when there is, or is supposed to be, any quantity of copper present, the heated mass is flung into baths of acids, which cause the copper to be precipitated, as well as other things which, like the copper, would be injurious or obstructive (in a less degree) to a subse-

quent operation. What remains is fine, and comparatively very soft; but up to this point any metallic iron contained in the quartz has remained undisturbed, and its removal is imperatively necessary.

Next in order, in the machinery department, we find a Jones' pulverizer, the action of which is similar to a pair of millstones. This machine is fed with water; and in passing through it, the material is ground extremely fine—almost to an impalpable powder. A very important operation is connected with the pulverization. After passing through the machine, the matter gets flooded into a trough; and over this trough there moves in an endless band or frame, about 500 moderate sized horse-shoe magnets, in rows of nine. The magnets almost touch the bottom of the trough, and in passing they attract the particles of iron, which they bring round upon their points; and the latter are cleaned by a stiff revolving circular brush, so that the magnets are again ready for duty, the iron from them being dropped into a closed box. There remains now little or nothing that will not form am amalgam with the mercury. Accordingly, from the trough, the material is carried into an amalgamator, which is a cylinder, 4 ft. long and 18 in. in diameter, open above, but egg-shaped below, where there is a tap affixed. The amalgamator contains 3 cwt. of mercury (quicksilver), which fills it to the height of 8 inches. A spindle causes to revolve in the mercury 4 perforated plates; and as the material dealt with finds its way through these perforations, every portion of it is brought into contact with the mercury. To make the mercury more active, it is heated and agitated by a steam jet; an idea, gained, we believe, from experience in hot climates, where it is found that, as a rule, the hotter the weather, the more complete and speedy will be the amalgamation effected. After being drawn off from the amalgamator, the mercury, with its golden charge, is distilled in a retort, great heat being required; and the mercury being driven off in vapor, and condensed in water, the residuum is gold, more or less pure, but generally having a very slight trace of silver. There are two locks to the retort. The comb-like mass in which the gold is taken from the retort is further dealt with; and the result, from the Chancellorsville quartz, is fine gold dust, said to be worth £4 per oz. in this country.

On Saturday the works were visited by some gentlemen from London, and by representatives of the metropolitan and the Manchester and Liverpool press. Amongst the visitors were Mr. Ansell of the assay office in the Mint; Mr. Henry of Lincoln's Inn Fields; Mr. Pemberton solicitor to the company, with several of the directors, the secretary, and Mr. Staunton, a large shareholder; several members of the London Stock Exchange, &c. Each of the processes was exhibited and minutely explained by Mr. Josiah Harris the manager; and the final processes were

gone through with what remained as the result of a ton of the Chancellorsville quartz, which had been previously dealt with up to what may be termed the magnet stage. It was explained, and seemed to be admitted, that it would not have been possible to exhibit during one day, the whole of the processes as applied to the same quartz.

The mercury was drawn from the amalgamator about four o'clock on Saturday; but as some alterations had been made in the appendages of the retort, and it was consequently quite cold until after half-past four, the result had not been arrived at by seven o'clock, and was not expected until near nine. We were, therefore, unable to remain until the end; but the opening of the retort was to be witnessed by Mr. Ansell and Mr. Henry, together with most of the other visitors. The result (as communicated to us) is as follows:—Fine gold 1 oz. 7 dwt. 7 gr., or about 1⅜ oz., or somewhat less than the average before stated.

The steam-power at the works consists of a forty horse horizontal engine, capable, when required, of working, easily, up to 80 horses' power. The present plant, we are told, is equal to the reduction of 20 tons of quartz a day; but the power is sufficient to drive a plant equal to the production of 50 tons a day. The works might be very much more extended. It would not be necessary, we understand, with the present state of the works, to distil the mercury oftener than once a week, supposing that during that time 20 tons a day had been reduced and worked through. The loss of mercury by distillation is from three to five per cent. We have already stated that the estimated cost of depositing the Welsh and Virginian quartz at the works, is respectively £1 and £1 10s. per ton; we may add that the estimated cost of reducing the 20 tons a day, as could be done at present, is £17; or 17s. a ton, all expenses for material, wear and tear, labor and contingencies, being allowed for. The average yield, per ton, is calculated at an ounce and a half of gold, worth £6. We shall not go into the statements we heard as to expected revenue from other materials produced in the operations; except to say that the sulphur is looked to as being very valuable, and that some of the Welsh quartz is alleged to be very rich in coxscomb mundic, which (as we understand) has been found to yield 7 ounces of gold per ton (of metal.) We were shown a heap of California quartz, which was described as having been worked in California, and 1¼ oz. of gold got from it; but which, nevertheless, had since yielded, in the hands of Mr. Harris, an average of nearly 3 oz. per ton.

COMMERCIAL ASPECT OF THE MINING INTEREST.

New York, Nov. 1st.

Since our last report there has been some activity in mining stocks, but at a great decline in rates. This decline has been occasioned entirely by the money crisis. The accounts received from the mining interest generally, are very favorable, from the Lake Superior region particularly so. The confidence in copper mining is becoming more general, and we do not hear the word "humbug" used so often in connection with this class of mining operations, as formerly. The public have become satisfied that the cause of past failures attaches not so much to the mines as to the officers of the companies working them.

From the Lake Superior Region, we have accounts from several mines that under former management had produced little or nothing, now being worked on the tribute system, or by competent and judicious management producing very favorable results. The shipments of copper this year have been large, an aggregate of four thousand nine hundred and sixty tons through the St. Mary's Falls ship canal, to the 1st of October, from the following mines:

Minnesota	1848¼	Isle Royale	81¼
Rockland	137	National	137
Cliff	1401¼	North American	143¼
Nebraska	27¼	Huron	26
Ridge	24¼	Pewabic	72
Connecticut	27¼	Toltec	9
Arctic	31¼	P. & B. Mc	213
Quincy	46	Copper Falls	66¼
Central	37¼	Portage Lake	132
Norwich	81¼	(Not reported)	316
Adventure	116¼		
Total			4966

The Boston *Courier* presents the following summary relative to the copper mining stocks in that market:—

Mining stocks of the better class, have run down with an unparalleled rapidity, and many of the heretofore low-priced concerns, Isle Royale, Flint Steel, Central Huron, Toltec, &c., have almost entirely failed out. Minnesota and Pittsburg, the only dividend-paying companies, have declined enormously, the former \$65 per share, and the latter \$48 per share in one month. The extreme decline in Minnesota has been \$104 per share, or from \$179, June 27, to \$75, October 8, equal to a depreciation in market value of \$2,080,000. This alarming downfall in Minnesota was occasioned, in a great degree, by the company being compelled to suspend the payment of the dividend of 7½ per share, due to-day, for want of cash means to pay it. This payment has been extended to February 1, and as the regular dividend would be due May 1, 1858, that may be postponed also, as it is hardly probable that means can be raised to pay two so near together. Pittsburg has fallen from \$288, July 18, to \$170, October 30, a loss of \$696,000 in value. The company has 6,000 shares, and the Minnesota 20,000. The decline in other mining shares from the highest prices have been very heavy; Rockland, \$20; National \$50 to \$20; Superior, \$14½ to \$5; Flint Steel, 50c. to \$2 asked; Copper Falls, \$14 (highest recently) to about \$4; Pewabic, 7¼ to 4¼; Isle Royale, (since the increase to 20,000 shares) \$5 to \$2 per share.

We give the following card for the benefit of our circulation:

OFFICE OF THE CUMBERLAND COAL AND IRON COMPANY,
No. 42 Pine st., N. Y., Oct. 13, 1857.

This company announce to the public that they have completed their organization under the "General Mining Law of New York," and have purchased 5,580 acres of the land on the forks of the Sandy, just westward of the Cumberland range, (from which they take their name,) which divides Virginia from Kentucky. The public are requested not to confound this company with any other association chartered by other States of the same or similar name. This company is entirely free from debt, and will commence active operations as soon as the times will permit.

W. J. PATTISON, President.

S. L. MORGAN, Secretary.

The above appeared in one of the daily papers in this city of very moderate circulation. We do not know what are the intentions of these parties, but from the fact of their assuming the name of an old and well-known company here, and also from the fact that neither of the names published as president or secretary are to be found in the New York City Directory, it would, therefore, be well enough for the public to be on their guard, and examine closely every certificate offered of the Cumberland Coal and Iron Company. If it has not the name of A. Mehaffy, president, it would be safe to let it alone. With a little care no mistake need be made.

NEW YORK COAL MARKET.

Nov. 1st, 1857.

There is a good business doing in domestic coal, the arrivals have been quite equal to the wants of buyers. The demand for cargoes to go east has been rather better; the improved feeling in financial circles has not been without its influence in this branch of business, but prices are without improvment. Sales by the cargo at \$4 a \$5 05 per ton, and from yard at \$5 10 a \$5 50 per ton.

COAL.—The market is unchanged for foreign, the demand is fair; sales of 100 tons Orrel at \$8 50, and 100 tons Cannel at \$10 50, 4 mos.

LONDON METAL MARKET—OCT. 28. 1857.

(From the London Mining Journal.)

		£. s. d.	£ s. d.
Copper.			
Copper wire	p. lb.	0 1 3½–	—
ditto tubes	"	0 1 4 –	1 4½
Sheathing and bolts	"	0 1 1½–	– —
Bottoms	"	0 1 2 1	2½—
Old (Exchange	"	0 1 0 –	– —
Best selected	p. ton	124 10 0–	nom.
Tough cake	"	121 10 0–	—
Tile	"	121 10 0–	—
South American	"	120	– —
Iron.			per ton.
Bars, Welsh, in London		8 10 0–	—
Ditto, to arrive		8 0 0–	8 5 0
Nail rods		9 0 0–	—
" Stafford in London		9 5 0–	10 0 0
Bars ditto		9 10 0–	10 10 0
Hoops ditto		10 7 6–	11 0 0
Sheets, single		11 0 0–	11 10 0
Pig, No. 1, in Wales		4 10 0–	5 0 0
Refined Metal ditto		5 10 0–	5 15 0
Bars, common, ditto		7 5 0–	—
Ditto, railway, ditto		7 0 0–	7 5 0
Ditto Swed. in Lon		14 10 0–	16 10 0
in stock to arrive		15 0 0–	16 0 0
Pig, No. 1, in Clyde		3 8 6–	3 9 6
Ditto, in Tyne and Tees		3 11 0–	3 15 0
Ditto, forge		3 10 0–	—
Staffordshire Forge Pig		4 15 0–	5 0 0
Welsh Forge Pig		3 15 0–	4 0 0
Lead.			
English Pig		23 10 0–	24 10 0
Ditto sheet		24 15 0–	—
Ditto red lead		26 0 0–	26 5 0
Ditto white		27 0 0–	28 10 0
Ditto patent shot		27 0 0–	—
Spanish, in bond		23 10 0–	23 15 0
American		none.	
Brass (sheets)	p. lb.	11½d.–	12½d.

Wire	11¼d.-12d.
Tubes	13¼d.-14d.
Foreign Steel.	Per Ton.
Swedish, in kegs	22 0 0– —
" to arrive	21 10 0–21 15 0
Ditto, in faggots	23 0 0– —
English, Spring	18 0 0–23 0 0
QUICKSILVER p. lb.	0 2 1– —
Spelter.	Per Ton.
Foreign	30 10 0–30 15 0
To arrive	30 15 0–31 0 0
Zinc.	
In sheets	36 0 0–36 10 0
Tin.	
English, blocks	140 0 0– —
Ditto, Bars (in barrels)	141 0 0– —
Ditto, refined	144 0 0– —
Banca	139 10 0–140 0 0
Straits	138 0 0– —

*Tin Plates.**		
IC Charcoal, 1st qua.	p. box	1 19 6–2 0 0
IX Ditto 1st quality	"	2 5 6–2 6 0
IC Ditto 2d quality	"	1 18 0–1 18 6
IX Ditto 2d quality	"	2 4 0–2 4 6
IC Coke	"	1 14 0–1 15 6
IX Ditto	"	2 0 0–2 1 6
Canada plates	p. ton	16 0 0–16 10 0
In London; 20s. less at the works.		
Yellow Metal Sheathing	p. lb.	11¼d. —
Wetterstedt's Pat. Met.	p. cwt.	2 2 0
Stirling's Non-laminating, or Hardened, Surface Rails	p. ton	9 0 0–9 2 0
Stirling's Patent Toughened Pigs	Glasg.	— –5 5 0
Ditto	Wales	4 0 0–5 5 0
Indian Charcoal Pigs in London		— –7 10 0

REMARKS.—Our market has evinced symptoms of a declining tendency. Copper, iron, spelter, and tin are mostly quoted somewhat lower; lead and tin plates are also easier, although the general quotations remain about the same as last inserted; the market altogether appears to have undergone a change, prices becoming easier under a limited amount of business.

COPPER.—We are unable to report any activity now in our market; the impetuosity exhibited amongst speculators to purchase at present prices, is abated since the advance in fixed rates seems likely to take place. Those parties who were so anxious to buy previous to the last sale of ores at Swansea, are now offering copper for sale, and smelters come forward with cake, which they previously stated was in such strong demand that it was quite impossible to supply any further quantity for some considerable time, and declined to entertain orders unless at the prices at the time of delivery, clearly showing the falsity of their representations.

IRON.—Rails are procurable at 7*l.* per ton, f. o. b. at the works; merchant bars, of common brands, being dull of sale, could also be purchased at 7*l.* 2s. 6d. to 7*l.* 5s.; sales having already been effected for forward delivery in London at 8*l.* per ton. Staffordshire exhibits a downward tendency: nail rods of best quality offering at 9*l.* 5s. f. o. b. here. Scotch pigs have been sold at 67s. 6d., m. n., but have again rallied, and sellers now quote 68s. cash, g. m. b., f. o. b. in Glasgow.

LEAD.—English pig of good quality has been offered at 23*l.* 10s. Sheet lead 24*l.* 15s. The market is quiet, but steady at these prices.

SPELTER.—The stock of spelter has much increased, the return here on the 1st instant, stated 1,963 tons; the transactions in this metal for some time past have been very insignificant, and holders at the present moment would readily realize at 30*l.* 10s. per ton.

TIN.—English remains without any alteration. Foreign has fluctuated; the closing price for Banca was 138*l.* 10s. for about 500 slabs, 140*l.* for a smaller parcel. Straits, 138*l.* nominal. There is evidently less disposition to operate on the part of speculators, although the deliveries in Holland last month were very large, at the same time it was prompt month, when it is usual for larger shipments to take place. Banca is reported to be had at the sale price in Amsterdam.

TIN PLATES.—Former prices are maintained.

STEEL.—No change of consequence.

* At the works, 1s. to 1s. 6d. per box less.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

SCHUYLKILL.

The quantity of coal sent by railroad and canal from Jan. 1 to Oct. 22, 1857, is:—

	Tons.
By Railroad	1,520,751
" Canal	1,020,739
Total by Canal & R. R.	2,541,490

Shipments to same period last year:

By Railroad	1,861,675
" Canal	940,630
	2,802,305
	2,541,490
Decrease in 1857, so far	260,814

LEHIGH COAL TRADE FOR 1857.—*From Miner's Journal, Pottsville.*

Total amount of shipments for 1857, to Oct. 17th:

By Canal,	Tons.
Lehigh Coal and Nav. Co.	319,629
A. Lathrop and others	2,857
Spring Mountain Mines	30,051
East Sugar Loaf do	20,731
Coleraine do	40,819
Stafford do	510
N. York and Lehigh Coal Co.,	25,368
German Penna. Coal Co.	7,311
South Spring Mountain Coal	15,042
J. B. McCreary & Co. N. S. Mt. Coal	10,179
Beaver Meadow Coal Co.	3,042
Hazleton Coal Co.	76,366
Cranberry Mines	55,488
Diamond Mines	23,112
Council Ridge	29,191
Mt. Pleasant Coal Co,	7,373
Buck Mountain Coal Co.	58,539
Wilkesbarre Coal Co.	816
Wyoming Coal	8,980
Hartford Coal Co.	19,743
Total	755,157

LEHIGH VALLEY R. R.

Spring Mountain Mines,	99,103
East Sugar Loaf do	78,177
N. York & Lehigh do	31,700
Council Ridge do	55,174
German Penna. do	6,359
Coleraine & Stafford do	38,874
Dolbin & Dehaven do	8,844
Hazleton do	42,893
John B. McCreary & Co	5,562
	366,690
	755,157
Total	1,121,847

Shipments during same period, last year:

By Railroad,	133,641
By Canal	992,150
	1,125,792
	1,121,847
Decrease in 1857, so far	3,944

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the month of Sept., 1857:

	Month.	Tons.
Union Canal	15,121	130,344
Swatara Railroad	8,982	94,765

LYKENS VALLEY COAL TRADE.

Lykens Valley Coal Company	50,523
Short Mountain Co.	44,223
Total	94,746

LACKAWANNA COAL TRADE.

Coal transported over the Delaware, Lackawanna, and Western Railroad for week ending Saturday, Oct. 17th, 1857:

	Week.	Season.
Shipped North	2,712	169,401
" South	2,079	267,168
Total	4,791	436,578
Coal shipped to the same period last year		75,709

DELAWARE AND HUDSON CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Oct. 15th	388,739
Last year	425,564
Decrease this year	36,825

PENNSYLVANIA COAL CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Oct. 15th	490,739
Last year	515,049
Decrease so far, this year	24,310

TREVORTON COAL TRADE FOR 1857.

	Tons.
Up to Oct. 15th	42,302

BROAD TOP COAL TRADE FOR 1857.

	Tons.
Up to Oct. 15th, 1857	65,589

MARYLAND COAL TRADE.

The Cumberland Telegraph of Oct. 22d has the following:—

"The Mining Interests of this section are well nigh prostrated. There is not much demand for coal, except on time, and we understand that the companies operating here, in the present condition of affairs, will not sell except for cash. We think they are wise. It will not do in heavy operations like theirs to run risks. Under the present aspect of the money market, unsettled as it is in all sections of the country, they are safe only when a fair equivalent in cash for the productions of their mines is attainable. They would be untrue to themselves and their employees to pursue a different course.

As a consequence of all this, but little coal is going to market. The shipment for the past two weeks has been small, and we doubt not it will grow less by degrees until the close of the season.

	Tons.
Total from the whole coal region for the year	473,649
Last year	523,195
Decrease	49,546

THE COAL FIELDS OF MICHIGAN—THEIR EXTENT AND QUALITY.

A correspondent of the *Detroit Tribune* furnishes the following to this paper:—

In my former letter, I cited the authority of the geographical explorations of the late Douglas Houghton, State Geologist, to prove the magnitude and quality of the coal fields of Michigan, which are destined to exert a powerful influence in the practical development of the wealth and industry of this State. But the lamented Houghton, with all the ardor of State pride and scientific enthusiasm, seems to have been too timid in his estimation of the "coal measures" of the Peninsular State, as well as his no less cautious Assistant, Bela Hubbard, who concedes "an irregular basin, covering an area probably of not less than 9,000 square miles." In his recent "Outline of the Geology of the Globe," Prof. Hitchcock, the accomplished Geologist, assigns to the State of Michigan, a coal field of 12,000 square miles. The existence then of an inexhaustible supply of coal must be admitted—its quality and facility for working have also been as amply proved by actual tests, under the supervision of a gentleman who was foremost in an enterprise which sought the development of this hidden wealth, and which it is not too much to say, would have, ere this, been practically successful, had not the work been arrested by the death of Col. Richard R. Lansing, the president of a company incorporated for coal mining in Michigan. In 1853, Col. L. laid bare a coal bed to an extent of 1,000 square feet, and removed to the surface about 60 tons of coal—the structure varying in thickness from 28 to 36 inches. Fourteen tons of this coal was transported to Detroit, and subjected to all the various purposes for which bituminous is generally used. The Superintendent of the motive power of the Michigan Central Railroad, Mr. Newhall, tested its quality, and fully certifies to its adaptation for forges. M. Eber B. Ward, who had its power to raise steam tested on one of his boats, testifies that "the coal burned freely, emitting a great deal of flame and raising steam rapidly, was reduced to ashes without exhibiting any evidence of sulphur, or clinker, or making any impression on the grates of the furnaces, which, after the experiment, were left as free from any adhesive matter as if wood had been burned."

Col. O. B. Dibble, of the "Biddle House," testing it in making gas, certifies that his "decided opinion is, the coal yields as much gas as any other domestic coal used for that purpose, and its luminous qualities certainly exceed any other gas manufactured." Mr. Francis Smith, an engineer of great experience in the making coke in the North of England, certifies that he made some experiments with the "Michigan Coal," and that he "had seen a gas retort charged with this coal three several times, and the coke yielded in these instances, was, throughout, of that uniform silvery appearance which is an invavariable feature in good coke, and, that his impression is, that this coal with proper ovens, would make as good coke as that now used in England, in firing Locomotives and blast furnaces." For domestic use, Adrian R. Terry, M. D., certifies that he "never, in the Western country, burnt a coal which gave so clear and brilliant a flame, and of which the coke (after the bitumen was burned out) made so permanent and hot a fire—leaving but an insignificant amount of ashes or earthy residue, in comparison with any coal I have ever burned in this region."

The coal with which these experiments were tried, was taken from Red Cedar River, 22 miles from Owasso—though, to use Col. Lansing's own words, as contained in his report, "*The quality of the coal at Shiawassee and Red Cedar Rivers, I know from personal inspection to be the same.*"

The quantity and quality of the coal deposits of Michigan having now been fully established, let us for a moment consider the necessity that already exists for their immediate working. Speaking of the coal fields of the State, R. E. Roberts, Esq., author of the "Sketches of the City of Detroit," says:

"About one hundred thousand tons of mineral coal is annually consumed in Detroit by manufactories, furnaces, gas-works and steamboats, and for

domestic purposes; all of which is at present brought from Ohio and Pennsylvania—while within a distance of less than one hundred miles from the city, extensive fields of superior quality of coal have been known to exist for many years past, but which could not be made available to us for want of a cheap mode of conveyance to this point. This is now soon to be afforded by the construction of the Detroit and Milwaukee Railroad, which passes directly through the coal district; when it is expected that our own coal fields will not only supply coal for the consumption of the city, but also the mineral region of the Upper Peninsula, at cheaper rates than it can be obtained from any other source."

The only portion of the great coal region which the completion of the Detroit and Milwaukee Railway opens for the economical use of Detroit, lies as far as developed, in the centre of Shiawassee county. Within a stone's throw of the railroad depot here at Owasso, and the junction of the Port Huron road, a coal deposit has been explored by Mr. A. G. Bradford, of Pennsylvania, a scientific gentleman of high attainments, who states that "the coal is of extraordinary purity—approaching in quality the 'cannel coal,'" and blending in its component parts all the necessary elements for every variety of use. In his report Mr. B. adds:

"From my coal explorations in several States of the Union, to which I have devoted the most of my attention for the past fifteen years of my life, I never saw coal at the out-crop of such extraordinary quality and purity, and so free generally from sulphur and other impurities."

At this point, the first stratum of coal, from thirty to thirty-six inches thick, lies about three feet below the level of the Shiawassee river, (where it occasionally develops itself in slight seams,) and rests upon a sandstone of from six to ten feet in depth—furnishing a good material for building purposes and justifying its being quarried, for the reason that none but scattered surface stone is to be found in all this region. Underlying this, is another stratum of coal, of considerable dip, and averaging four feet in thickness—which in turn rests upon the blue and yellow clays of the Kidney iron formation. This ore consists of nodular masses, formed of concentric coats or layers of iron combined with lime and salumine, and surrounding a hard nucleus which frequently contains fossils, and is analogous to that which is worked extensively, and with profit, in Ohio. The clay is free from lime, of even texture, and consequently adapted to all the purposes of the kiln or pottery, and far superior to any found elsewhere in the State. Under this valuable deposit—more valuable, under the circumstances than the coal—is another layer of bituminous coal of about six feet in depth, preserving a dip of about ten feet in every hundred feet of extent. In order to obtain coal of approved quality, it is essential that the dip of the bed should be followed down until it is removed beyond atmospheric action, and the coal pressed down into a compact state by the weight of heavy superincumbent masses. It follows therefore, that in the process of subterranean mining of coal in this locality, if drifts are set in along the strata, there will be no waste in rubbish, for the whole mass of excavation will be *coal quarrying stone, potter's clay, and iron ore*—each worth much more than the cost of excavation, and all to be found within hailing distance of the Detroit and Milwaukee Railway Depot at Owasso—spreading two miles in extent.

To open this field of enterprise and industry at once on the completion of the railroad to this place, two or three of the capitalists of Owasso had nearly completed the necessary arrangements, and this fall was to have witnessed the first regular coal-mining operations in the State of Michigan. But I regret to learn, that the present financial derangements have prompted those gentlemen to postpone their operations until next spring; when, I doubt not, a new era will dawn upon the State, and she will soon no longer pay tribute abroad for that article so bountifully bestowed upon her by nature.

That Michigan will soon need the use of her bituminous coal, must be apparent to the casual observer. Independent of the hundred thousand tons of

coal annually consumed in Detroit, as claimed by Mr. Roberts, in a preceding extract, on pursuing the inquiry for demands in the interior of the State, and particularly in the State of Illinois, I learn from most excellent authority, that a material amount of this coal will be needed for blacksmithing purposes in this State, and a much larger amount, when converted into coke, in the various blas t furnaces scattered over the northwest, instead of the anthracite coal of Pennsylvania, which is generally used, and only obtained at high prices. The great number of railroads, which are constantly increasing, and the enormous quantity of wood annually consumed by their locomotives, must force the railroad companies, by the increasing cost of wood, to adopt the recent improvement by which bituminous coal can be used, upon their roads. Indeed, in some of the populous portions of the State, the want of wood is already felt, and the time is near at hand when the want of wood for fuel in regions destitute of wood land, must be forcibly realized. Besides home consumption, the western portion of the peninsula is being rapidly drained to supply the immense prairie regions on the western side of Lake Michigan—the Michigan Central and Southern roads having of themselves for years consumed annually between Chicago and Niles and South Bend, over 80,000 cords of wood,—and on which section the Rock Island and Illinois Central Railroad have also long been dependent for their fuel. The demand, therefore, for the bituminous coal of Michigan cannot be doubted, and I rejoice in the prospects of the future industry which the great coal fields in the interior of the State will so surely develop, and add to the general wealth and prosperity. In a year or two, I doubt not, Owasso will become the "Reading" of Michigan.

IRON AND ZINC.

IMPROVEMENTS IN THE MANUFACTURE OF IRON AND STEEL.

Considerable curiosity has been expressed in reference to the inventions of M. L'Abbe Pauvert, of Chattellerault, France, in consequence of an exciting notice which appeared some time since in the letter of the Paris correspondent of the *Times*. We take the earliest opportunity, therefore, of making known the nature of these improvements in the manufacture of iron and steel. The inventor has obtained patents for three inventions in this country. The first—for "certain improvements in manufacturing iron"—is thus described by him:—

"The object of this invention is to deprive or drive off from puddled iron sulphur, phosphorus, and other metalloids, by cementation. It is applicable to puddled iron in any of its stages or states. I employ a cement composed of the following substances: 14 parts (by weight) oxide of iron: 30 highly aluminous clay; 50 carbonate of lime, or wood ashes; 4 finely divided charcoal; 1 carbonate of potassa; 1 carbonate of soda. These proportions need not be rigorously adhered to, but may be varied, and one or more of the substances composing the cement may be dispensed with, according to circumstances and the nature of the iron. I place the iron with the cement in layers into a cementing furnace, and I heat the furnace in the ordinary manner. This iron, after cementation, is welded, and then drawn into bars. It thus becomes as soft and as tenacious as iron made with charcoal. The many electric currents produced by the mutual reaction of the elements, the reduction of the earthy and alkaline metals, and of a portion of the oxide of aluminum, favor the escape and absorption of phosphorus, sulphur, and other metalloids. In order that all the carbon may be decomposed and disappear in the state of oxide or carbonic acid, it is necessary that the carbonates and oxides should be in excess."

The second invention—for "certain improvements in manufacturing cast steel"—he thus describes :—

"The object of this invention is to decarbonize cast iron by prepared oxide of iron, and to free it from gaseous and solid metalloids. I crush cast iron heated to a red heat, under rolls, or under a tilt hammer, or broad-faced forge hammer. The portion of the cast iron reduced to a fine powder serves for the preparation of the oxide, while that which is in coarser particles serves for reguluses or metal. To render the oxidation complete, the powdered cast iron is wetted with pure, acidulated or alkalized water. To obtain cast steel I have recourse to the processes and apparatuses now used for fusing. I place in a melting pot from 33 to 40 parts (by weight) of oxide, prepared as just stated, to 100 parts of crushed cast iron; to every 100 parts cast iron 8 or 10 parts of the following composition are added (which must be kept as free as may be from exposure to the air): 4 parts (by weight) dry carbonate of soda; 4 dry carbonate of potash; 3 wood ashes; 2 borax; 3 oxide of manganese; 4 to 7 hydrogenated carbon, soot or lampblack. These ingredients should be carefully mixed, but the number and proportions may be varied according to the product desired. Instead of oxidized cast iron, iron filings or iron raspings may be used, the same being oxidized by the same process. Instead of 4 parts dry carbonate of potass, 2 parts caustic potass may be employed. The numerous reactions of these ingredients produce the following effects :—1. The generation of numerous electric currents. 2. Complete reduction of the manganese and oxide of iron (produced by the oxidized cast iron or iron filings) which unite with the steel. 3. Reduction of the earthy and alkaline metals and borax which absorb the metalloids. 4. Disappearance of the *nitrous* gases, because potassium, sodium, and calcium, reduced in presence of steel and of carbon in an incipient state, absorb *nitrogen*, and form cyanides of potassium, sodium and calcium. 5. Formation of larger crystals in the steel, when it cools down, than have hitherto been produced in steel."

The third invention—for "certain improvements in manufacturing steel and cast steel"—he describes as follows :—

"The object of this invention is—1. To purify iron, and to combine it chemically with carbon by cementation. 2. To convert it into cast steel of superior quality, whatever the nature of the iron first employed, I make use of a cement composed of the materials and in aboout the proportions following:—33 parts (by weight) of finely divided charcoal; 33 parts of highly aluminous clay; 33 parts carbonate of lime or wood ashes; 1 part carbonate of soda; 1 part carbonate of potash. I stratify the iron with this cement in an ordinary cementing furnace, and heat it in the same manner as is now generally followed. I thus obtain a steel possessing all the qualities of that known as German or "Rives," or shear steel (*acier d'Allemagne ou de Rives*). The successive heats and firings do not cause it to part with the carbon which is intimately combined with it, as in cast or in shear steel. And for this reason, carbon having but a small affinity for iron, requires, in order to enter into intimate combination with it—1st, to be added in an incipient state; 2d, to be assisted in its combination by numerous electric currents. Now these conditions are fulfilled by my process, for—1st. The mutual reaction of the carbon and the carbonates causes the greater part of the carbon to assume a molecular state; 2d. This *change* of the carbon and of the carbonates, the action of the red-hot iron upon the oxides of aluminum, of calcium, of potassium, of sodium, with the carbon in the molecular state, produce or generate numerous currents of electricity. Further, the earthy and alkaline metals appearing in an incipient state, greedily absorb sulphur, phosphorus, and the other metalloids. Thus prepared, this steel may be used as shear steel or German steel (*acier d'Allemagne*), the properties of which it possesses. In order to convert this steel into cast steel, the ordinary processes of fusing in pots is followed, but with the addition to the metal in the pots of from 5 to 6 per cent., by weight, of the following

mixture, which, as far as possible, must be kept from contact with the atmosphere:—4 parts (by weight) dry carbonate of soda; 4 parts dry carbonate of potash; 3 parts wood ashes; 2 parts borax; 3 parts oxide of manganese; 4 to 7 parts hydrogenated charcoal, soot, lampblack, &c. The four parts of carbonate of potash may have substituted for them two parts of caustic potash. The mixture of these substances should be effected with care, and their number and proportions may be varied to suit the nature of the products to be obtained."

The reactions of these substances are said to be the same as in the former case.—*London Mechanics' Magazine.*

IRON AND STEEL MANUFACTURE.

There is one metalloid which I have never even seen conjectured as likely to be an alloy of steel, and yet nothing is more probable. All the steel iron on the Continent, including that of Danemora, or the best marks of Russia, are acknowledged to be smelted from mixtures in which the spathose ores constitute the principal parts. Now, all those ores, as well as the minerals used for fluxes, particularly at Danemora, contain comparatively large quantities of *magnesia:* and hence the pig or cast metal made from such mixtures will, beyond doubt, if properly smelted—that is, a fully carburetted pig obtained—be found to contain a notable portion of *magnesium* in combination with the iron and other metallic elements of the pig. Of this fact we have the sage authority of M. Berzelius, who states that, in the analysis of best Swedish pig-iron, he found it to contain—

Iron	90·8	
Silicium	0·5	in 100 parts.
Magnesium	0·2	
Manganese	4.57	
Carbon	3·83	

Now, it is a fact very well known among investigating chemists, that when any two or more metals are chemically combined—that is, alloyed together—it is an exceedingly difficult matter to cause a complete separation of them. Hence, we may rest perfectly satisfied that, whatever metal or metalloids may be combined in pig or cast-iron in the smelting process, there will always be a minimum of such alloy remain in the wrought-iron or steel made from such pig or cast-iron, be the processes of manufacture whatever they may. Hence we have another reason or cause for the manifold shades of difference in the qualities of both steel and iron, for the same principles govern in both cases. My examinations on steel have been very circumscribed: my whole attention during a long life has been devoted to the investigation of the nature and properties, and to their actions and re-actions in the blast furnace, of iron-making materials, almost exclusively; but from even the very slight examinations I have made with respect to cast-steel, I have seen sufficient to be convinced that the samples I operated upon did contain, in the analytical result, *magnesia*, which, to me at least, was proof enough of the presence of *magnesium* in the steel in question—a metal of "silvery whiteness, comparatively soft, and exceedingly malleable." Now, may not a small alloy—even 1-500th part of this metalloid, be the cause of the high estimation in which certain Swedish irons are held by steelmakers? This I consider to be a point entitled to the best consideration of cast-steel makers in particular; for if fully established, we should have the way opened to the production of iron in our own country equal for steel-making purposes to any foreign iron whatever.—*Rogers's "Treatise."*

MANUFACTURE OF IRON.

Amongst the many inventors who, according to the opinion of an eminent practical man, have been amusing themselves by "playing at iron-making," scarcely any two of them have entertained a similar opinion with respect to

the particular chemical compounds which give a superiority to one class of iron over another. One will try to produce a chemically pure metal, on the supposition that purity must be the desideratum; another thinks that if the sulphur and phosphorus could be removed, the iron would be of the best quality: while a third supposes that he has discovered the philosopher's stone, and proposes to introduce a small percentage of nitrogen, "as its existence in good quality iron has never received an adequate amount of attention, and therefore claims the use and production of cyanogen compounds, wherewith he will be enabled to imitate, in its chemical combination, the most sought for description of iron.

Notwithstanding the opinion of practical men that the excellence of iron is as much due to mechanical as to chemical causes, the iron chemists are disinclined to acknowledge that chemistry is unable to become a substitute for careful mechanical manipulation. Messrs. F. C. Calvert, F.C.S., and Richard Johnson, have just completed a series of interesting experiments on the chemical changes that pig-iron undergoes during its conversion into wrought-iron. The pig-iron experimented upon was No. 3 gray pig, which on analysis gave—iron, 94·052; carbon, 2·275; silicium, 2·72; phosphorus, 0·645; sulphur, 0·301; and traces of manganese and aluminium. Two cwts. of this was introduced into the puddling furnace, and forty minutes after the first sample was taken from the centre of the molten mass with a large iron ladle, and poured on a stone flag to cool. On breaking the sample as it was taken out of the furnace, it had no longer the appearance of No. 3 gray pig, but a white, silvery metallic fracture, similar to that of refined metal. The rapid cooling of the sample was no doubt the cause of the change noticed, for it contained quite as much carbon as the pig-iron used; and further, the carbon was in a very similar condition, as in both cases a large quantity of black flakes of carbon floated in the acid liquors in which the iron was dissolved.

Upon analysis it was found that during the 40 minutes which the iron had been in the furnace, two opposite changes had taken place, for whilst the proportion of carbon had increased, the quantity of silicium had rapidly decreased, there being now 2·726 of carbon, and 0·915 of silicium. After the iron had been one hour in the furnace, a second sample was taken out, when this curious fact was still further apparent, there being then 2·905 of carbon, and 0·197 of silicium. It had the same white silvery appearance as the previous sample, but was slightly malleable under the hammer, instead of being brittle. The scoria also was on the upper surface of the mass when cold, and not mixed with the metallic iron. Five minutes afterwards, the mass in the furnace having become very fluid, and beginning to enter into the state called "the boil," a small quantity was ladled out. When cold it was quite different from that of the two previous ones, being composed of small globules adhering to each other, and mixed with the scoria; the mass, therefore, was not compact like the former ones, but was light and spongy; its external appearance was black, and the small globules, when broken, presented a bright metallic lustre, and were verry brittle under the hammer. They had for some time considerable difficulty in separating the scoria from the globules of iron; but found that by pulverizing the whole for a long time, the scoria was reduced to impalpable powder, and by sieving they could separate it from the iron, which was much less friable. This iron, thus cleansed from its scoria, gave of carbon 2·444, and of silicium 0·194.

As soon as the last sample had been taken, the damper of the furnace, which had been closed after the first sample was taken, was slightly raised, so as to admit a gentle current of air, which did away with the smoke that had been issuing from the puddler's door. This was done, no doubt, to facilitate the oxidation of the carbon of the iron, and to increase this action, the puddler quickly agitated the mass. Under this treatment the mass swelled rapidly to four or five times its original bulk, and in 15 minutes (1 hour 20 min. from the commencement of the experiment) the fourth sample was

taken. Whilst cooling small blue flames of oxide of carbon were seen in various parts of it, no doubt arising from the combustion of carbon by the oxygen of the atmosphere. This sample was so light, and formed of such minute granules, as to be exactly like an ant's nest. The particles had no adherence to each other, for by the mere handling of the mass it fell to pieces. The granules had a black external appearance, were very brittle under the hammer, and when broken presented a bright, silvery, metallic fracture. The analysis gave—carbon, 2·305; silicium, 0·182.

The fifth sample, taken out 15 minutes after the preceding, was an important one, as it was the first in which the iron was malleable and flattened under the hammer. It was ladled out just as the boil was completed, and the swollen mass had began to subside. The damper was drawn up, and a rapid draught thus caused. The puddler changed his tool, using the puddle instead of the rubble. It was less granulated than the fourth sample, and still in separate globules, black externally, but bright and metallic when flattened. The carbon had greatly decreased, whilst the silicium remained almost stationary, the analysis being—carbon, 1·647; silicium, 0·185. As the mass rapidly transformed itself into two distinct products—scoria and malleable iron—the sixth sample was taken, five minutes after the fifth, but the appearance was similar, except that the scoria was not so intimately mixed with the globules of iron, and that these were larger, and slightly welded together when hammered. The next sample, although taken out but five minutes after the sixth, had the granules rather larger, and nearly separate from the scoria, which formed a layer at the top and bottom of the mass. The granules were more malleable. There was then of carbon, 0·693; and of silicium 0·163. In the eighth sample, taken five minutes after (1 hour 50 min. from the commencement of the experiment), being a few minutes before the balls were ready to be removed from the furnace, and placed under the hammer (it was part of one of the balls separated and placed to cool), no blue flame issued from the mass as it cooled, but it was still spongy and granulated. The granules, however, required a certain amount of force to separate them from each other, and were much more malleable under the hammer. The analysis gave—carbon, 0·772; silicium, 0·168; so that it appears that in 15 minutes from the time when the boil was completed, the iron lost 50 per cent. of the carbon which it then contained.

The balls were hammered and rolled into bars, which were found to contain—carbon, 0·269; silicium, 0·120; sulphur, 0·134; phosphorus, 0·139; and when these were cut into billets, 4 ft. in length, heated to whiteness, and rolled into wire iron, the proportions were—of carbon, 0·111; silicium, 0·088; sulphur, 0·094; and phosphorus, 0·117. An analysis of the scoria which remained in the furnace after the balls were taken out showed it to contain—silica, 16·53; protoxide of iron, 66·23; sulphide of iron, 6·80; phosphoric acid, 3·80; protoxide of manganese, 4·90; alumina, 1·04; lime, 0·70—100. Therefore the silicium, phosphorus, sulphur, and manganese, which existed in the pig-iron were found in the scoria, and probably the phosphorus and the silicium were removed from the iron by their forming fusible compounds with its oxides. The importance of such experiments as these cannot for a moment be questioned, and both theorists and practicals must benefit from the facts here recorded.

THE MANUFACTURE OF IRON IN OHIO IN 1857.

The progress of the manufacture of iron in all its departments, notwithstanding though rapid it has been for some years past, still continues unabated; and the productions of this department of our industry, have found their way into new markets during the year. The scarcity of coal was a serious injury to this as well as all other departments of manufacturing, as business had to be suspended to an alarming extent during two of the winter months, thus diminishing the quantity of work which could otherwise have

been done; but after navigation opened, orders having accumulated, all our shops were taxed to their utmost capacity, and a larger quantity of work was turned out during the spring months and all through summer, than ever was in the same time before. The iron trade is in a very healthy state. The demand has been fully equal to the supply, and at no time have stocks accumulated.

By an arrangement made between the railways of Indiana and Illinois, iron in all its various forms is being transported hence to Illinois, Wisconsin, and Iowa most extensively without re-shipment, the same cars running to each point of destination. In this way the business doing with the North-west has increased fifty per cent. A few days ago an immense iron bridge for some railway in Northern Illinois, was taken from the establishment of one of our manufacturers to its destination by railway.

The market for pig and bar iron has been very steady during the year. In the first four months consequent upon the inadequate supplies, owing to low water, prices of Ohio hot blast pig ruled at $34 and $36 per ton, but after navigation opened the price fell to $30, and at this rate the market has been steady up to the close of the year.

The increase in the number of establishments during the year engaged in the iron business is shown by the following:—

	1856.	1857.
Iron foundries and machine shops,	32	37
Rolling mills,	11	12
Stoves and hollow ware,	7	8

The following table shows the exports of manufactured iron for twelve years:

Years.	Tons.
1846	1238
1847	5646
1848	6916
1849	6270
1850	5767
1851	9776
1852	11829
1853	14246
1854	18322
1855	11978
1856	11881
1857	16064

The following table shows the imports of Pig Iron for twelve years:—

Years.	Tons.	Years.	Tons.
1846	13685	1852	23604
1847	15868	1853	30179
1848	21145	1854	41807
1849	15612	1855	26613
1850	17211	1856	41016
1851	16110	1857	29848

JOURNAL OF GOLD MINING OPERATIONS.

MOUNT HOPE MINING COMPANY.

In December last, the Mount Hope Mining Company (late Rocky Bar), on Massachusetts Hill, having nearly exhausted their ground above their then lowest level, resolved to make the effort to strike their ledge at a depth not heretofore attained in any mine in the State. Accordingly a shaft was commenced for that purpose, and after a tedious and expensive labor, occupying a period of seven months constant work, night and day, and an expenditure of about $30,000 on the shaft alone, the most sanguine anticipations were fully realized by striking their vein at a perpendicular depth of 241 feet, or 350 feet, following its dip. Two hundred and five feet of this distance was driven through solid rock, first slate, gradually changing into the most unyielding greenstone, and costing the whole distance, $130 for each perpendicular foot.

The first tub full sent up from the ledge gave no less than twenty five specimens, which showed coarse gold. They have since gone down three feet into, and probably through the vein, which is here divided into three distinct plates or layers of five or six inches thick, with the intervening spaces filled with "pay dirt," which affords prospects indicative of an extraordinary yield. Little doubt is entertained but that the vein at this point is fully as rich as at any which has yet been opened.

The great depth at which the vein is now opened proves its richness to an indefinite extent, and secures for the Company an immense amount of working ground. It also shows that we may look with the utmost confidence for the continued richness of our quartz veins, generally, to any depth which we may choose to follow them. The success of this undertaking will infuse new life into all the quartz miners in this neighborhood, and will not be without its benefical effects on the business of quartz mining generally, throughout the state.

GEOLOGY OF GOLD.

As gold and quartz and tin oxide were unsociable and refractory substances, they would be the first to take their place in rocky associations, for this reason they are coeval. That gold and tin are not always confined in veins, but often disseminated in their vicinity; they were not so often embedded in quartz as in the interstices; that other substances besides quartz very frequently contained gold; that quartz from its hardness was the only thing that resisted trituration and stuck to gold to exhibit what we called specimens; that I had taken 18½ ozs. of gold from quite another substance, on the property of Mr. J. B. Neales, of Adelaide, and sent it to the Exhibition of 1851, similar samples of which I have here with me. I must observe that those who understand shallow deposits, and prefer them, do best finally—much gold, and sometimes big nuggets, existing between the depth of 6 inches and 6 feet. A great use may be made in this country of the honeysuckle in this respect, and much sinking and searching saved. A tree, or line of trees on the side of a hill would indicate an arenaceous bed on the bottom, although in a steep hill, as witnessed on the Loddon or Kangaroo diggings. I think it due to myself to say that my lecture, in print, as delivered three years ago, suggested a trial there, at a time when I spoke of gold lying below the trap about the Loddon, Mount Franklin, and the Pyrenees; and the idea of its existence in such positions had not been tested anywhere. As it regards the exploration of quartz veins the chances of finding gold are as great at 6 ft. as at 60—it is cheaper, and with a better chance to keep near the surface. Then, as to the working, there is only one rule—drive until you come to it, then either sink or rise after it, or sink

in possession of gold, but not in search of it. Sink as long as you can see it; and when it works out, contend not with the difficulties of increased depth, but try a new surface. The statistics of gold mining *in situ* prohibit deep mining. Then as to exploration for gold upon the earth's surface, first we must look for the protrusions of the early rock, satisfy ourselves that it is granite or primitive schist, never broken up by any power whatever; in fact, the bottom showing itself at the top, and possibly half concealed lumps of ore or metal stuck into it, as the bottom upon which all sedimentary materials rest. We must examine the hollows near such protrusions, and if we find very large, very round, very hard, and very smooth boulders of quartz, or any of its concomitants, we may conclude that the sea has done its great work for us. If the primitive hills were not gold-giving, we could not expect the sea to beat out any for us; but if they were, we shall, by working, find our "pile" somewhere among and under these boulders. They are a clue to deposits when lying upon auriferous granites; if these originally were rich, and the sea had not worn down a portion and rested the gold on the bottom for us, we should not be fairly invited to dig, the absence of these boulders denoting that Nature has nothing for us.—*From a Lecture, by Mr. John Phillips, in Victoria.*

ENORMOUS YIELD OF A QUARTZ BOULDER.

A large boulder of quartz was found in a ravine near Pilot Hill, El Dorado county, from which 74 lbs. of rock were broken from the richest portion, which, when melted and assayed, yielded $1760. The entire weight of the boulder is estimated at from 1100 to 1800 lbs., and it is thought the yield will be over $15,000. Messrs. Dayton and Bunkmeir, the owners of the prize, have been for a long while, in company with two others, working the claim with a poor return, and but a few days before the discovery bought out their two partners by paying each $600 for their interest in the claim.

LIBERTY MINING COMPANY.

We clip the following report from the *London Mining Journal*, and seriously commend it to the attention of officers of our Wall street gold mining companies, especially to such of those as are in doubts as to their ability to extract individual expenses from their worthless stock certificates.

The Liberty Mining Company of Virginia have advices from Mr. Conquest, the managing director at the mine, wherein he states:—"I have had the engine and all the machinery thoroughly overhauled and repaired, and commenced running the stamps on May 22; and on June 18 I took the first bar of gold to the bank, which weighed 52 ozs. 12 dwts.: this is the result of running 26 days, averaging 11 hours a day only, and working hard slate and quartz rock, which passed very slowly through the mills. I shall stop next week, and send all my hands into the mine, while I put up two more Chilian mills. I shall be able to pay my way from the day I commence running, and am determined that when the old debts are paid no more shall be incurred while I am manager. I intend to raise sufficient ore to run 24 hours a day; this will involve a second set of hands in the mill-house, and also an increase of from 20 to 30 hands; and having the machinery to make the mine pay, I only require the necessary force to keep it fully employed. I fear I cannot procure the additional force now, as in a fortnight they will commence the harvest. At Christmas I can obtain the needful supply, and hope by that time to satisfy my brother shareholders that their property is really a good one. I regard this property and conduct it in every way as if every cent came out of my own pocket. The utmost economy is enforced by me, and all now do their duty. We have hit upon a splendid new vein of superior quality in the new shaft we are now sinking, and all hands are much pleased with it, so that my prospects of ultimate success are most cheering, and I think the shareholders may bid adieu to their doubts and fears, and carry out my recommendation to pay off

all the old liabilities without delay; let them set me free of these, and I will make the mine pay, and they shall never be called on for another pound as long as I am here."

ADDRESS

TO THE QUARTZ MINERS OF CALIFORNIA.

There assembled at *Sacramento*, on the 18th of June last, a convention, the importance of which is second to *no* convention that ever assembled in the State of California. It was composed of the quartz miners of that State. The object of their assembling, as will appear by an address, the result of a committee appointed by the convention, was for a free and mutual interchange of opinions and experience. The business of mining (gold mining in particular) is susceptible of deriving great benefits from mutual intercourse. Dr. Stephen R. Leeds, an editor of this magazine, has, in an article entitled *Experience in Gold Mining*, published in these pages in 1855, clearly demonstrated the importance of this movement. We append the address entire.

Nine years have elapsed since the world was astounded by the fabulous reports of the gold discoveries of California. About two years subsequent, the discovery of gold *in place* was also announced, and the world was still more astonished by the extraordinary richness and extent claimed for the gold-bearing quartz veins of our State. By this new discovery a fresh impetus was given to the "gold fever." Specimens were selected and sent to all parts of the world. Many were assayed, and their yield made the basis of calculations for the average working of veins, upon which companies were formed, with large capitals, in San Francisco, New York, London and Paris. Each company dispatched hither its corps of scientific and practical men, with large amounts of money, machinery, &c. In some instances mills were erected, but none of the veins, when opened, and subjected to a practical test, proved equal to the report of the assay, and a very few only, were found to pay even the expenses of working.

Great was the disappointment at the discrepancy between the yield of the ore, by the practical working of machinery, and the estimates based upon the assays. Hence arose the cry that "the gold is in the ore, but we cannot save it!" That cry was answered by the production of a host of new machines to reduce the ore, and to amalgamate the gold. One by one these machines were tried and condemned, until nothing remained but what had stood the test of ages. The greatest difficulty which had to be encountered, was the high cost of freight and labor, which precluded the possibility of working any but the richest veins. This for a time could not be overcome, and mill after mill, which had been erected at a cost of from twenty to fifty thousand dollars, was abandoned, and left to rot and rust upon the ground. A few, only, of those who first embarked in the business continued to persevere. These, mostly with limited means, and without credit, subjected to the jeers and derision of the "knowing ones," pushed on with their labors year after year, their condition gradually improving, as their expenses lessened, until comparative success crowned their efforts. Their perseverance and final triumph encouraged others, until gradually the discouraging effects attendant upon the early failures have now nearly passed away, and a degree of confidence has obtained which occasional reverses, that may hereafter occur, will have no power to shake. Quartz mining is now steadily advancing to its irresistible position as the leading industrial pursuit of the State. Under the present improved method of extracting and saving the gold, nearly all engaged in the business are receiving fair returns for their investment,

while in many cases almost fabulous results are realized. Mines that three or four years ago were considered worthless, and abandoned as such, are now being reclaimed and worked at a handsome profit.

Few persons have any accurate idea of the present extent of the quartz mining interest, or the rapidity with which mills are being multiplied in every mining county in the State. There are now at least $5,000,000 directly invested in the business, giving constant employment to not less than 10,000 persons. A little over one year ago, according to the most accurate statistical information which could be obtained, there were but 67 mills in operation in the entire State; while there are now 162 known and recorded, to say nothing of at least 800 arastras which are at work independent of any other machinery. Not a week passes without adding to the number; and we believe it safe to assert that ere three years shall have elapsed, from this date, we shall have on record upwards of 500 mills, while there will yet be room for many thousands. Veins of quartz that will pay for working have been discovered from one extreme of the State to the other—north and south, and from the foot hills to the very summits of the Sierra Nevada.

That all who embark in the business will succeed, cannot be hoped for; yet we maintain that with prudence and foresight, fewer failures *need* ensue than in any other business in any part of the world.

It is upon the business of quartz mining, that we must mainly rely for a permanent mining population, one which will retain its earnings to enrich the State, rather than as heretofore to transmit them abroad for foreign investment, or to sustain families "at home."

That quartz mining will induce a permanent population, look at Grass Valley. There are quartz mills, saw mills, a grist mill, tanneries, breweries, foundries, machine shops, seven churches, school-houses, &c., all sustained chiefly by this business, while the appearance of comfort which surrounds the dwellings, bespeak a permanence rarely to be met with elsewhere in California; yet what Grass Valley is, other locations will become.

It was to promote the interest of this particular branch of mining that the late Quartz Mining Convention, held at Sacramento, organized the State Association already alluded to, and selected the "Californian Mining Journal," published at Grass Valley, in Nevada county, as its official organ. A subscription of $5,00 entitles a person to membership, and a copy of the "official organ" for one year. The immediate objects of this Association, are to cause to be prepared and published, essays of a practical character pertaining to quartz mining, also information with regard to any novel treatment of the ores, sulphurets, &c., with the results; description and merits of new machinery, valuable statistical information, and such information generally as shall be deemed of practical utility to the quartz mining interest.

In order to facilitate this work a central committee was appointed, consisting of one from each county represented, whose especial duty it is made to collect and procure the publication of this matter, in the official organ, or in such other manner as the committee may deem proper.

It is hoped that this committee will not neglect the important matters committed to their charge, and that if any remissness in their duty has hitherto occurred, they will endeavor, now that the excitement of the election is over, to set about it in earnest.

A Registry Office was also established, by vote of the Association, to be placed under the charge of the Register, who has located said office at his place of residence in Russville, opposite Folsom, on the American River, where books are now opened for the registry of mines, the deposit of specimens, the description of veins, &c., &c., all of which is intended to facilitate the sale, or purchase of quartz mining property.

The organization of this Association contemplates an annual meeting, which it is hoped, will be generally attended, for a free and mutual interchange of opinions and experience. The utility of these annual gatherings is

abundantly exemplified in the progress of our agricultural and various mechanical communities. The principle of association—the practice of frequently bringing men together, bent on the same general pursuit, uniting their intellectual and physical efforts to the same general purpose, has long been admitted, and the beneficial effects of its application to quartz mining is confidently expected. The advantages of these annual gatherings are derived not so much from public discourse, as from the meeting of men together in familiar conversation, so that they may compare practice with one another, and learn each the experience of others. It is by this meeting face to face and talking over together what they have in common interest, that makes men sharp, intelligent, communicative to others, and ready to receive intimations in return. Therefore, it is hoped that this organization will not be suffered to wane, but that it will increase in numbers and influence, until it shall embrace the entire body of quartz miners of California. Any person desiring to become a member can do so on application to any one of the Central Committee, and paying over the initiatory fee. The names of this committee may always be found in the columns of the official Journal.

The business of mining is peculiarly susceptible of deriving benefits from mutual intercourse, as it is not at all affected by competition. The success of one in no way operates to the disadvantage of another, as there is not the slightest probability of a "glut" of the market in consequence of an over-supply of the article produced. Hence miners, and especially quartz miners will find it greatly to their advantage to hold frequent intercourse by meeting together in neighborhoods, counties, or in general convention, for the purpose of imparting and receiving such information as shall tend to the advancement of their co-laborers. Mining is emphatically a generous pursuit, and should induce none but liberal feelings.

Our mines are a rich inheritance for our working men, which they can enter upon and develope with their own industry, if they will. It is a great mistake which many persons make when they assert that we must depend upon foreign capital, mainly, to develope and work our mines successfully. A judicious combination of labor, skill and capital, is the surest mode of developing the wealth of any country. Such combinations, when properly brought together, are capable of effecting wonders. They are becoming quite frequent in California. They *should* become much more so. It might not be without profit if the Central Committee of the Association should prepare and cause to be published, some plain and practical suggestions by which persons desirous of forming such associations might be governed, both in their associate organizations and in the laying out of their work.

It is particularly incumbent upon every member of the Association, and, indeed, upon every quartz miner, that he should take every convenient opportunity to impart to the central committee, to his neighbors, or to the Editor of the "official organ," any information which he may have acquired which shall be new or important in its character.

It is a combination of "little springs" that makes up the swelling tide of the important river. Our entire knowledge of agriculture, of mechanics, of navigation and of mining had its origin in those "little springs" of human experience, which when taken separately, appear but trifles; but which collectively, make up the sum total of human knowledge. Then let no miner think that his individual knowledge is of no importance, for the experience of every practical miner is a "little spring," that of every company is a "babbling brook," while every County Association is an important river—all of which, when united, will form a broad stream of knowledge, upon which the mining world may embark with confidence, as upon a great highway, open and free to all who may wish to try their fortunes upon its shining tide.

SAMUEL PURDY.
HORACE P. RUSS.
WARREN B. EWER.

August, 1857.

NEW MACHINERY FOR EXTRACTING GOLD.

Quartz miners are now turning their attention with more than usual earnestness to the devising of some means for working over and extracting the gold from the piles of "tailings" which for several years have been accumulating about most of the early constructed mills. The fact has long been recognized that these "tailings" contain a large quantity of gold, and various are the methods which have been tried for its extraction. In addition to the Mexican Arastras, several other machines, for more rapid and economical working, have been tried in this place, and elsewhere in the State, but nothing has been introduced which comes up to the desired point of excellence.

Within the last few weeks, however, we have examined models of some three or four machines, designed for reducing quartz tailings, which have not yet been put to a practical test. They each have their merits, and will, doubtless, soon be introduced to public notice, when our readers will duly be informed of their practical value.

Mr. Daniel Burdick, an ingenious mechanic, well known in this place, is the inventor of one of the machines above alluded to. He is now putting up one at the Empire mill, and will have it in operation in a few days. This machine is extremely simple and cheap in its construction, and, it appears to us, must, when put in operation, accomplish a large amount of work in a very thorough manner.

As the machine will be pretty satisfactorily tested before our next issue, we will say no more of it at present, but wait and let it speak for itself. Whoever succeeds in accomplishing the desired result in this department of quartz mining, will not only secure an ample fortune to himself, but will also become a public benefactor, by materially advancing the entire quartz mining interest of the State.

SHIPMENTS OF GOLD FROM SAN FRANCISCO.

The following is a statement of the treasure shipped hence during the past quarter, on steamers, combined with the previous shipments of the year:

To New York	$8,140,256 94
To England	2,299,918 55
To New Granada	104,007 52
Total for the three months, .	$10,544,178 01

The shipments during the first half of the year, by steamers, to New York, amounted to $16,934,766 16; to England, $4,364,115 38; to New Granada, $220,921 25. These amounts combined with the above would make the entire shipments, for the nine months, as follows:

To New York	$25,075,623 10
To England	6,664,028 93
To New Granada	324,928 77
	$32,063,980 80

The amount exported at a similar period in 1856, was $36,134,066 14, showing a falling off in 1857 of $4,070,185 34.—*San Francisco Herald.*

JOURNAL OF COPPER MINING OPERATIONS.

THE PHALAN TRACT—LAKE SUPERIOR COPPER REGION.

A correspondent of the *Detroit Tribune* contributed the following interesting piece of information to that paper—

"Another of those reckless sales of Copper stock, which have so much injured the mining interests of Lake Superior among eastern capitalists, is about to take place. I understand, a company has been organized and a conditional purchase made of what is called the 'Phalan tract'—a few fractions of land on the Ontonagon river, containing about 160 acres. The contract price to be paid for this land by 'the Company,' is understood to be $15,000, provided 'the Company' can sell the stock, although the estimated value put upon it is $60,000, while the stock value may be made to represent $500,000. Surveys of the vein of the National mine have been made, and plans drawn, showing that the 'National' veins run into the tract in question. But there is no evidence that such veins run into or across the tract in question; nor have they ever been opened; the earth is too deep over the rock; there are no rocks exposed, and they are covered too deep with the alluvial of the Ontonagon river for the operators to incur the trouble of an examination for copper before selling the stock. This is another 'Shawmut' operation, and is reported to be only the first of a series of such operations contemplated for the ensuing winter's speculations.

"Our country has suffered more from the effects of such 'stock operations,' and the enormous and extravagant prices thus paid for lands, without any knowledge of any thing of value upon them, than from the improper and bad management of the mines. It is high time that such operators, who have for years been putting upon the market unexplored grounds for mining enterprises, should be looked after by the public press of this State and of the Atlantic States."

It is seriously to be deplored, that interested or maliciously-inclined persons or parties find so easy access to the columns of respectable journals. The above paragraph has been copied by several of the journals of the Eastern cities, as though it was highly important and incumbent upon them to expose the shave, as indeed it would be if it had truth for a foundation. The editor of the *Upper Peninsular Advocate*, who is on the spot and understands what he says, puts this affair in quite a different light. After speaking of the author in rather strong terms, he proceeds as follows:—

"Another Shawmut affair," is referred to, as though the parties who induced the organization of that Company had been a party of swindlers. The bare suggestion in this portion of the country to every old resident, practical miner, or mining engineer, is regarded as an outrage, and a villainous aspersion of the character of as honest and high-minded men as can be found at *the East*. At the formation of that Company, the indications in favor of a mine, of unsurpassed richness, were second to none ever formed on our great mineral range, and when the Company suspended operations the evidences in favor of a most valuable mine were never so promising. Every Upper Peninsula Stockholder paid up assessments, and were anxious to prosecute vigorously the work. It was the *Eastern* stockholders who did *not pay;* it was they who crippled, stopped, and suspended the work, and all the swindle there was consisted in the loss of thousands of dollars by reason of that fact, by the early pioneers and men of toil in the Upper Peninsula, who had not

the means to go on with the work, unaided by foreign capital. Such is the fact as applied to that mine and many others.

The truth is, Mr. *Tribune*, too many sharpers and speculators *down east* have taken stock in our proposed mines, not with reference to their working and being developed, or intending the payment of assessments, but to speculate on the stock. To many of this class of men, the too confiding owners of valuable tracts of land have given, without consideration, large interests for the purpose of aiding in the development of their own property, and then they have abandoned the owner, who spent perhaps years of toil, and endured every hardship and privation incident to the exploration and settlement of the country, to take care for himself; but the evil will correct itself, and we trust that in future our citizens and owners of valuable tracts of land, will be more guarded in the selection of those duped, cheated, and deceived honest men of the East as stockholders.

We know that our mountain ranges possess wealth beyond computation, and although such articles as referred to in the *Tribune* may, and do have mischievous consequences—do not only operate to the injury of individual citizens, as well as prove detrimental to the country at large. That mischief, however, is only temporary. While we regret to advert to this subject at all, we feel that common justice to the country, and citizens engaged in mining operations, whether resident here or at the East, renders it necessary.

OGIMAW MINE.

This mine (the Spalding location) made their first shipment of copper a few days since, consisting of 11,767 lbs., estimated at 75 per cent. This is the product of two months' work of five men, all the force at present working, and certainly speaks favorably of the value of the property. The mining has all been done on the tribute system, the miners receiving one half of the net copper, and paying all expenses except transportation.

A MOUNTAIN OF COPPER.

"A correspondent of the Richmond *Enquirer*, writing from Floyd county, Va., says:—

Mr. Toncrey, of Floyd, has recently opened a copper mine on his plantation, which, in my opinion, contains the richest mineral in the world—it is a mountain of copper. We passed through the mines in the morning, and, though we felt somewhat fearful in thus passing under the mountain, we were astonished at the sight of such an immense quantity of rich ores all around us. There are several tunnels penetrating the mountain which pass through various veins of different kinds of ores. There is a vein of red oxide about eighteen feet wide, the ore of which yields about seventy-five per cent. There are veins of the black and brown ores, about one hundred feet in width. The black ores yield sixty and the brown from thirty to thirty-five per cent. He has recently struck on a vein of yellow sulphate, which yields from twenty-five to thirty per cent. This vein is about twenty-five feet wide, going down nearly perpendicularly. To all appearances it is inexhaustible.

COPPER AND LEAD MINES OF MISSOURI.

Near Fredericktown, in Madison county, east and west of it, rich *copper mines* have been discovered, but as yet worked but little, if any, and are now lying idle. In one of them the native copper, *in large masses*, as at the Lake Superior mines, has been discovered, giving every evidence of one of the richest kind of mines. *Copper*, it is well known, is one of the most valuable of the common metals; and these mines would be well worth the attention of

miners, who wish to make money. There are also traces of copper on Doe Run, and very probably rich mines, as also in other places in this region.

Lead mines.—There are lead mines to be met with almost everywhere in the region comprising the counties of St. Francois, St. Genevieve, Madison, and probably others which I have not visited. In Madison county, about four miles north of Fredericktown, are the mines La Motte, or La Motte lead mines. These are the oldest in the State, having been discovered 150 or 160 years ago. Immense quantities of lead have been smelted, and a great deal of money made at them, and the leads are still as rich as ever, and the ore apparently inexhaustible. Nor is lead the only metal found here; but there is also nickel, cobalt, and copper, generally found in combination with the lead. These mines once employed about 1,000 hands, but owing to the property being now involved in litigation, there are only about 50 employed. While I am on the subject, I will remark that there is a rich lead mine a few miles west of Farmington, in St. Francois county, just over the St. Francois river, but not worked, and never has been, as I have learned. A few miles further west, on the waters of a creek called Doe Run, are lead mines, from which I procured one of the richest specimens of ore I ever saw, so rich that bullets could be run from it, without smelting! They have never been worked any. In the western part of St. Genevieve county, on the lands of Mr. John Coffman, is one of the richest kind of lead mines, the ore apparently inexhaustible. It has been worked a little, but is now lying idle. And in the southwestern part of the county, is another very rich mine, on the lands of Thomas Bryan, Esq., a brother of Dr. John G. Bryan, sen., of St. Louis, which has never been worked; while there are no doubt other mines elsewhere. I am thus particular in specifying these for the benefit of capitalists, or men of sufficient capital, who may be disposed to engage in this business, which is a *very profitable one*, when pursued by those who understand it, and for the purpose of bringing these resources of the State into notice, which, thus far, have been greatly overlooked. Since the Potosi mines are *said* to be *failing*, it will be well to call attention to *other* lead mines of the State. I will also mention that there can be fuel obtained, in different parts of these sections, in the greatest abundance, particularly in St. Genevieve county.

Marble.—It is but little known that there is *marble* in Missouri, or at least in this part of it. There exist quarries of the finest marble, in at least two sections of the country. One of these is about three miles northwest of Pilot Knob, in the new county of "Iron," where there are several quarries. The principal one is Cobb's quarry, and belongs to John Cobb, Esq., of Farmington, St. Francois county, the Clerk of the County Court of that county.

This marble is beautifully variegated with *red*, and is succeptible of a fine polish. It seems to abound in great quantities, and has been taken to Washington City, for the Washington monument, and also to St. Louis. The writer saw a gentleman at the quarry, from that city, engaged in having marble quarried for an important monument there for the dead.

In the southwestern part of St. Genevieve county, is an extensive quarry of the most beautiful *black* variegated marble, that has not yet been worked, and the existence of which is scarcely known. It is also on the land of persons with whom a favorable arrangement can be made for working it, as well as the lead mine on Mr. Bryan's land, and that on Mr. Coffman's.

Why should these mineral resources—this great mineral wealth—thus lie neglected? Why should those in other States, with fewer facilities and advantages, be developed, while these of your own State, with, too, as good facilities for transit to market, lie in obscurity and almost unknown? Let miners and capitalists who wish to invest money in mining, turn their attention to this part of Missouri. As to *health*, there is not a healthier country to be found anywhere on the globe, than this great mining region—one where there are fewer local causes of disease, and where the people enjoy better health. The country is also finely *watered*, with never-failing springs and streams of the

purest water; and in several sections, the *agricultural* resources are excellent—abundantly sufficient to support any sized mining or other population.

Salt Springs.—It is also but very little known that there are any *salt springs* in Missouri—but there are. In St. Genevieve county, about seven and a half miles from where Saline Creek empties into the Mississippi river, are salt springs, sufficiently strong and bold to be well worth attention, and in the neighborhood of immense quantities of wood for fuel. There was once considerable quantities of salt made at them, but they now, from some cause or other, lie, or rather *run*, neglected. Why should this be? Why such quantities of valuable salt water be suffered to be run off and be wasted? and that too when, properly managed, it is a money-making business, and, being so near the great "Father of Waters," the facilities for tansportation are so easy and cheap? Salt is one of the great necessaries of life, which the world cannot do without, and must always be in great demand, and bear a good price.

COPPER SHIPMENTS FROM THE LAKE SUPERIOR REGION.

SAUT ST. MARIE, Sept. 14th, 1857.

The following is a statement of copper that has passed the St. Mary's Falls Ship Canal since July 24th, according to reports made at this office.

Mines.	*Tons.*	*Lbs.*	*Total.*
July 26th			
Minnesota	25		
Rockland	30		
Nebraska	6		
P. & B. M. Co.	10		
Norwich	10		
Prop. Iron City			
Central Mines	12		
Isle Royale	9		
Aug. 2d			
Adventure		10.600	
Adventure		16,799	
National		5,460	
"		21,832	
Ridge		3,145	
"		625	
North American		3,000	
"		17,000	
Aug. 7th			
Minnesota		96.621	
Rockland		85,849	
Norwich		3,333	
Nebraska		2,262	
Isle Royale		20,382	
Aug. 13th			
Cliff Mine	150		
Connecticut	8		
Huron	10		
Aug. 17th			
Adventure		18,097	
"		40,514	
National		8.959	
"		1,559	
Ridge		10,900	
Arctic		6.144	
"		1,191	
Aug. 18th			
North American		29,037	
Minnesota		82,175	
Rockland		4.056	
Norwich		9,165	
Nebraska		4,203	
National		19,889	
Toltec		18.015	
Quincy		17,324	
Portage Entry		14,259	
Aug. 19th			
Minnesota } Rockland }	100	319	
Aug. 28th			
Arctic		6,205	
"		14,674	
Adventure		6,549	
"		4,319	
Ridge		1.457	
Isle Royale		31.145	
Pewabic		44,212	
"		4,414	
Huron		9.082	
"		1,396	
Connecticut		1,780	
"		3,927	
Aug. 29th			
Minnesota	125		
Sept. 3d			
National		5,514	
"		18,704	
Minnesota		282,176	
"		7,496	
Rockland		30,741	
Norwich		8.764	
"		5,918	
Nebraska		3,339	
"		5,822	
Cliff		85,336	
"		47,212	
Sept. 4th			
Quincy		14.944	
"		1,944	
Portage Entry		9,437	
Arctic		635	
"		354	
Adventure		6,348	
"		7,375	
Ridge		4,187	
Total tons			1220 915

Yours Respectfully, ALVIN BURT.

MISCELLANIES.

MANUFACTURE OF COMPOUNDS OF ALUMINA AND MAGNESIA.

Mr. D. Baker, Gisbro' Alum Works, Yorkshire, has invented some improvements in the manufacture of compounds of alumina and of magnesia. For these purposes, in making a compound of sulphate of alumina and clay, the liquors obtained from alum rock or other aluminous shales, by the application of sulphuric acid to the burnt shales, or by adding water in the usual way, are used: such liquors, obtained by either process, are evaporated to a certain gravity, when clay is added, by preference china or Dorset clay, and the mass is allowed to solidify. In carrying out this part of the invention he prefers to employ large lead pans heated by under flues. The liquor is heated so as quickly to evaporate the excess of liquor and bring the same to about 90° of Twaddel, when a quantity of clay in a state of powder is stirred in, so as intimately to mix the compound; the quantity of clay may be varied, but it is preferred to employ one of the clay to 19 of the liquor when brought to the specific gravity above mentioned. When the clay has been well stirred in, which will take from about 10 to 15 minutes, the whole is run off to solidify, the stirring being continued as long as it can be conveniently done. The compound thus produced is suitable for paper makers and others in substitution of alum and other aluminous compounds, where great purity is not required. When using shales containing alumina and magnesia, as in the case of the Yorkshire alum shales, the compound produced as above will consist of sulphate of alumina, sulphate of magnesia, and clay. In some cases sulphate of magnesia, obtained as at the Yorkshire Alum Works, or manufactured from magnesian limestone and sulphuric acid, is used, and having brought a solution to the desired gravity above described by evaporation, the clay is added as before, and the compound is allowed to solidify. These compounds as first described, are applicable in the manufacture of paper, and otherwise where great purity is not desired. In some cases a compound is prepared to be used as well as the preceding (in place of alum), though applicable for purposes where greater purity is requisite; the sulphate of ammonia, sulphate of potash, muriate of ammonia, muriate of potash or soda, one of which salts is necessary for the manufacture of alum, being in this preparation dispensed with. For this purpose are used liquors obtained either by the application of sulphuric acid to the calcined aluminous shale or rock, or by adding water in the ordinary way, such liquors containing sulphate of alumina; or if from shales or rock like Yorkshire alum rock, then containing sulphate of alumina and sulphate of magnesia. In this manufacture the clarified liquors obtained by either of the processes before stated, when containing sulphate of alumina only, are evaporated to the proper gravity (about 96° of Twaddel) and then drawn off to solidify; and this preparation is suitable for the paper maker for the finer classes of paper, as well as for other uses; or, when the liquors contain both sulphate of alumina and sulphate of magnesia, they are evaporated in the manner before described, and allowed to solidify, when, as in the previous case, the product will be suitable for paper makers and others. The quantity of sulphate of alumina or of sulphate of magnesia may be varied from those naturally contained in the liquors by adding one or the other when evaporating the liquor. He finds it advantageous when great purity is desired to continue the application of heat some hours after the liquors have been run off, which allows time for the settling of impurities, or when a known gravity is attained (from 96° to 106° of Twaddel), the sulphate of alumina is separated from the sulphate of magnesia, by the sulphate of magnesia being driven off by heat; he then introduces sufficient of the soda of commerce or other alkali to neutralize any free acid consequent on driving off the magnesia. In cooling, the product solidifies, and is the product desired, and is suitable in the

manufacture of finer classes of paper and other uses. There is a residuum precipitated in clarifying aluminous liquors which has hitherto been run to waste. In the Yorkshire shales and those of like nature, it contains portions of sulphates of alumina and magnesia, the moisture of which being evaporated is used in making a preparation or compound for paper stainers, and for making common papers.

THE PAR OF STERLING EXCHANGE.

The principle on which American merchants and bankers calculate exchange on England is thus clearly set forth by a correspondent of the New-York *Mirror*:

The par of exchange is determined by the relative proportion of pure metal in the coined piece which forms the unit of price in the different countries of the world. The alloy is reckoned of no value.

To simplify the matter as much as possible, we will waive all consideration of the different standards of fineness, and state that our American dollar contains 23.22.100 grains of pure gold, and the British sovereign 113 grains of the same. Every reader may not know that the sovereign is the coined piece of which the pound sterling is the money of account. A simple calculation in the rule of three, therefore, determines that the equivalent of the pound sterling is $4.86, 65.100 of our currency.

Thus, as 23.22.100 is to 1 so is 113 to $86.66.100. But as the English, through all the variations of the mint laws, here and elsewhere—indeed for ages—have been accustomed to value their pound sterling by the old Spanish carolus pillar dollar, now entirely out of circulation in Europe and America, having all been sent to China, or gone into the melting pot. Of these $4.44.44.100 were equivalent to the pound sterling. It will be seen that it requires the addition of 9 1-2 per cent, with a scarcely appreciable fraction, to make the present value of the pound sterling in our curency.

Thus	$4.44 44.100
Add 9 1-2 per cent. premium of exchange .	42.22.100
	$4.86.66.100

It may be well to explain that when nothing is said to the contrary, the quotations of sterling exchange are by custom for bills at 60 days' sight, which at the legal rate of interest here involves a loss of one per cent. besides the time of transmission. But, on the other hand, at the most favorable rate of shipping specie, one per cent is the cost, including insurance, of laying it down in Liverpool, the time lost in transmission being the same in either case. Thus, as one of these items balances the other, the true par of exchange is 9 1-2 per cent on England, at which rate generally it is as well to remit good 60 day bills as specie.

MINING LAMPS.

The following is a detailed report of a paper read by Mr. E. W. Binney, at the Manchester Geological Society.

Since the discovery of the lamp by Sir H. Davy, in 1816, when I produced a light enclosed in a cylinder of wire gauze, 8 in. high and not more than 2 in. in diameter, the wire being when twilled not les than 1-40th of an inch in thickness, and 30 in the warp, and 16 to 18 in the weft. and when plain not less than 1-60th of an inch in thickness, and from 28 to 30 both warp and woof, little has been done in the way of improving it. In common use throughout the United Kingdom the lamp is pretty much the same as when it came out of the hands of the inventor. For simplicity, utility, and cheapness, the

lamp will, in the opinion of most practical men, be preferred to any yet introduced. The inventor especially cautioned workmen against allowing the gauze cylinder to be heated to dull redness, and moving it against a strong current of air. He saw what we all now know after 30 years' experience, that the Davy lamp was a safe instrument in the hands of a careful man who knew the principles on which it was constructed. It never was his idea that it was to be opened and closed like the door of a common lantern in the open air, placed on the stoping floor of a mine, with dry coal dust on the outside, and oil spilled on the gauze in the inside, moved swiftly against strong current of an explosive mixture, or placed under a falling mass of coal, and crushed into all kinds of shapes. Yet it is well known that the lamp has been subject to all these varieties of hard usage, and very unreasonably expected to prove a safety lamp.

I will now notice several lamps which have been more or less in use:—

1. That invented by the late George Stephenson, a man equally eminent in practical as Sir H. Davy was in theoretical science, and who, without doubt, produced a mining lamp before the latter philosopher. This lamp in its most complete state, when it was known in the north by the name of the "Geordie lamp," was like a common Davy, with a wide glass cylinder in the inside and close to the gauze. It has never been in great use, owing to the glass being liable to break, and from its going out in an impure atmosphere sooner than the Davy. So long as the glass is entire the lamp must be safer than a Davy, and when broken it must be as good as that lamp, but still the opinion amongst workmen has been that when the glass was broken it was not safe.

2. The Upton and Roberts' Lamp.—This has the gauze in the inside of the glass instead of the outside. Like the Geordie, last named, it is liable to go out in a foul atmosphere sooner than a Davy. It is no doubt a safe and useful lamp, but its expense is greater than that of the Davy, and its increased cost is not compensated for by its greater safety.

3. The Solar Mining Lamp.—This has never been in general use. It consists in placing a solar lamp inside of a common Davy. The gauze was of a dangerous width, being nearly 3 in. in diameter—a very serious fault in a mining lamp.

4. Clanny's Lamp.—This is a lamp with the gauze within the glass. It has come into considerable use in the North, but many parties object to the glass on the outside, being liable to be broken, and the light going out in an impure atmosphere.

5. The Mueseler or Belgian Lamp.—This is in considerable use in Belgium, but it has not progressed much in England. It is a light simply enclosed in glass, and consequently not near so safe in general use as the lights protected by glass and gauze.

Besides the above an immense number of new lamps have been introduced, but I merely allude to these five in order to show such as have been introduced into a mine and had a fair trial by ordinary use. In most of them it will be seen that the pricker to trim the wick is in the same rude state that Sir. H. Davy left it. Mr. Sherwood, of Birmingham, has brought out a lamp having a glass chimney in the inside of a wire gauze, something similar to the lamps of that class above-mentioned, but the wick, which is a flat one, and the burning apparatus, is quite different to that adopted in any of the above lamps. The wick takes up by capillary attraction a light oil (Young's parrafine or mineral), and passes through a flattened tube, where it is capped with a brass nozzle, having a long slit in the top and plenty of air holes in the sides. When the wick is lighted a great current of air impinges on the flame as it passes through the slit in the nozzle, and thus insures a perfect combustion, such as has not hitherto been effected in any other mining lamp. The light makes little or no smoke, and requires no snuffing for 24 hours, and it can be raised up and down by an adjusting screw in a much simpler and more effective manner than in any other mining lamp now in use. The lamp is new, and up

to this time has not been used in a mine. Its light was contrasted with a common Davy and the five lamps above slightly noticed, and it appeared superior to any of them. The inventor stated that it only consumed 1½d. worth of oil in 15 hours.—A favourable opinion was expressed on the advantages of the new lamp, but it was suggested that it be tried in a mine, and Mr. Sherwood placed it in the hands of Mr. A. Hewlett, of the Ince Hall Coal Company, to be tested in their mines.

GEOLOGY OF THE CARBONIFEROUS SYSTEM.

Bristol Mining School.—The second lecture in the course for the new session was given by Mr. M. Fryar, on the "Geology of the Carboniferous System." It was of importance that every one engaged in mining operations should have a general knowledge of geology, but particularly of the rocks in which, and in connection with which, the mineral is found they were principally employed in extracting. The Carboniferous system might be looked upon as taking a kind of middle position in the geological scale, and affording a clue for the miner and geologist to the discovery of the geological relative position of strata, either higher up or lower down. Older geologists, including Connybeare and Phillips, had treated the system as comprising the coal measures proper, millstone grit, carboniferous limestone, and *old red sandstone;* whilst others had omitted the old red sandstone, and included the new, because of this latter and the coal measures proper containing so many fossil plants alike. In Scotland, and in some parts of Ireland, the divisions seemed to favor that of upper coal measures, carboniferous limestone, and lower coal measures; but the arrangement by modern English geologists, and that now most generally adopted, was that of coal measures, millstone grit, and carboniferous limestone. The carboniferous or mountain limestone occurred as the lowest member of the carboniferous series, according to the last classification. It was sometimes found entirely beneath the coal measures, whilst in other districts it alternated with the shales and sandstones of the coal measures. In both cases it was destitute of land plants, but usually found containing remains of marine animals. It was generally of imperfectly crystalline texture, and sometimes sufficiently close to form marble, capable of taking a durable polish. Its color was generally grey, sometimes a greyish white and yellow, or a greyish blue and black, and occasionally a shade of red color might be observed. It was most commonly found to contain about 96 per cent. of calcareous matter, but sometimes passed into a kind of magnesian conglomerite, when it received the name of Dolomatic, from the French geologist, Dolomiew; at other times it was found as a ferruginous or bituminous limestone. Like other formations, it varied very much in thickness, but had been found in some places to be from 900 to 1000 ft. It was of some importance in a mineralogical point of view, as in it occurred the principal lead ores in Northumberland, Durham, York, Derbyshire, and Somersetshire. Of other metalliferous ores a few, and in more or less abundance the sulphuret, carbonate and phosphate of lead, antimoniated lead ore, sulphuret and carbonate of copper, sulphuret, carbonate, and oxide of zinc, the sulphuret and oxide of iron; also many varieties of common calcareous spar, arragonite, varieties of fluor, selenite, carbonate and sulphate of barytes, and sulphate of strontian. The strata were often highly inclined, especially in the south-western counties, where they sometimes become nearly vertical, and were traversed in some places by extensive faults.

The millstone grit, which generally formed the underlie of the coal measures, was commonly found as a rather coarse-grained sandstone, consisting in some cases of quartzose particles, sufficiently large to give the rock the character of a pudding-stone. It differed from other sandstones of the coal measures by its greater hardness. It sometimes assumed a very fine texture, and appeared as a hard, solid, flinty rock. Occasionally the metalliferous veins of the mountain limestone extended upwards into this series of strata, and in them

occurred nodules of clay-iron-stone, and iron pyrites. They appeared to form a transition series, from the marine deposit of the carboniferous limestone to the fresh water, or estuary, one of the coal measures. Vegetable impressions, analogous to those of the coal strata, had been found in the upper shales of the series, whilst organic remains, decidedly of marine origin, had been found in some of the lower.

The coal measures proper consisted of a series of alternating argillaceous shales, coal seams, layers of ironstone, and beds of sandstone. Besides this vast deposit of carbonaceous matter, thin seams of coal were found in other geological positions, as in the oolites of Yorkshire, and at Brora, in Sutherlandshire. The new red sandstone was the overlie of the coal formation in the Bristol district, but in the Newcastle-on-Tyne district this was wanting, and its place taken by the magnesian limestone. The shales, with their interstratified and conformable coal seams, varied in inclination from the almost perfectly vertical to the horizontal. Numerous dislocations of the strata had taken place since their formation, by the volcanic upheaval of vast basaltic dykes, by which fissures and slips had been produced over extensive areas. The different kinds of coal appeared to be immense masses of vegetable matter, in various stages of decomposition. Göpert had shown, by microscopical observation, that the coal consisted chiefly of the fossil ferns, such as Sphenopteris, Pecopteris, and Newropteris; or the trees or reeds, Sigillaria, Lepidodendron, and Calamites. Each bed of coal was associated with an under-clay, in which were found the root of the Sigillaria and the Stigmaria. A section of coal deposit in North America, at Cape Breton, as given by Sir Charles Lyell, showed Stigmaria in the under-clays, remains of Sigillaria above the coal bed, and the coal as mineralized vegetable, being the forest jungle, and the wreck of the forest trees compressed.

Mr. Fryar gave a detailed account of the theory respecting the formation of coal, and of the organic remains found in connection with it. There was but little probability of finding any extensive coal seams out of the coal measures, hence the necessity of becoming thoroughly acquainted with their position and character.

THE FRACTURE OF METALS.

Mr. Braithwaite, in a communication to the Institution of Civil Engineers, states that having carefully examined the circumstances of accidents, the causes of which have been pronounced mysterious, and having closely inspected the condition of the metal fractured, his conclusion is, that almost a such accidents may be ascribed to a progressive deteriorating action, whic may be termed the fatigue of metals. Metal in a state of rest, although sustaining a heavy pressure or strain, as in a beam or girder, and exhibiting only the deflection due to the superposed weight, would continue to bear that pressure without fracture, as long as its rest was not disturbed, and the same strain was not too frequently repeated. But if either of these cases occurred, a certain disturbance of the articles took place, the metal was deteriorated, and that portion subject to the reiterated strain was so far destroyed that it ultimately broke down.

This might also arise from sudden concussions, when the metal was under a certain strain, and those concussions might be caused by the girder being suddenly unloaded. The repeated buckling of the tube plate of a locomotive, arising from the action of the pistons, has a tendency to cause fracture mechanically. The side strains and vibrations to which suspension rods of the ash pans of the locomotives are subjected, have produced also very serious results. Mr. Braithwaite contends that, presuming adequate dimensions to have been given to girders, and the stipulated weight not to have been exceeded, the chances of accident are remote; but that any repeated deflection, either at intervals or continued so long as to induce a permanent depression, must be productive of danger, which can only be averted by altering or replacing the parts deficient in strength.

MINING IN 1665.

In turning over the first volume of the *Philosophical Transactions*, I found a number of queries propounded by the celebrated Robert Boyle, which may interest such of your readers as are curious about the ancient history of mining. He reduces his queries into six heads, and I think it would puzzle any one at the present day to suggest a better mode of investigation: 1, the neighboring country about the mines; 2, the soil where the mines are; 3, the signs of mines; 4, the structure and other particulars about the mines themselves; 5, the nature and circumstances of the ore; 6, the reduction of the ore into metal. To give his queries in full would occupy too much space, but some of them are exceedingly sagacious—others not a little amusing.

Under the first head, he asks whether the country be flat or mountainous?—whether the mountains run in ridges or not?—if so, do they run north and south, &c., or in any way *parallel* to each other?—whether the country be fruitful?—whether the cattle are at all peculiar?—whether the natives are subject to any epidemical disease, and what are the conditions of the air and water?

Under the second head, he asks only one question—"Whether the soyle that is near the surface of the earth be stony—and if it be, what kinds of stones it abounds with—whether it be clayie, marlie, chalkie, &c.—and if it be of several kinds, how many they are, and by what properties they are distinguished?"

Under the third head, he asks the two very pertinent questions—"By what signs they know or guess that there is a mine in such a place?" and "Are the signs upon the surface of the earth or beneath it?" Under these two subdivisions, in a multitude of questions, he asks—What are the effects of the presence of minerals upon the ground and trees—whether they change and discolor the water—whether frost or snow will not lie near them so long as in other places (this is a common idea at the present day)—and whether the dew or rain will discolor white linen cloth spread over night on the ground? Also, "Whether the place be more than ordinary subject to thunder and lightning, and to sudden storms or earthquakes, as likewise to nocturnal lights and fiery meteors?" The nocturnal lights is a favorable belief at the present day; though, if the indication be correct, the fens of Lincolnshire should be our best mining district. He also asks, "whether the *virgula divinatoria* (*vulgarice*, dowsing rod) be used to find out the veins of proposed mines, and with what success?" Under the second subdivision, he asks—"Be there any clayes, marles, or other mineral earths, yellow or liquid matters, that usually give notice of the ore—whether there be any stones or marchasites (mundic) to be found near—whether heat or damps give any assurance of finding a mine—whether water is a good indication—and lastly (most important question), what signs are there that the mine will be good, or indications that it is hopeless?"

About the fourth title, he asks the depth of the shaft or grove—whether the veins run north and south, or east and west—what are its dip and width, and how it is timbered—how the mine is supplied with air, and whether the water is quick? "Whether the waters are constant or temporary—whether they increase or diminish in winter or summer, or at any other time of the year—and if they do, at what season that is, how long it is wont to last, and the proportions of increase or decrease?" This is an interesting question, not satisfactorily answered at the present day. He then inquires as to the means adopted for pumping—whether they trace their passages underground by the loadstone, and how they guard against its deviation caused by ironstone?" "How the miners deal with the rocks and spars they often meet with before they come to the ore—whether they use fire to soften, calcine, or crack them?" and "What ways and cautions they use to free the mine, and secure the workmen from the inconvenience and danger of much fire in it?" As Savery's engine was not introduced till 1699, the fire here alluded to must probably have been for "softening and calcining the rocks." Robert Boyle,

who certainly had a clear head for detail, then asks, "How the men work, naked or clothed—what lights they use, what materials they are made of, how long they last, what measure of light they give, and how they are kept burning in that thick and foggy air?" The next question is curious—"How they convey out their ore and other things—whether they do it in baskets drawn up by ropes, or upon men's backs—and if in this last-named way, what kind of vessel they use, for matter, shape, and capacity—and whether the workmen deliver their ore to one another, or the same workmen carry them all the way—and whether the diggers (fancy a Cornish miner being called a digger!) descend and ascend by ladders of wood or of ropes?"

His questions under the fifth head are very interesting as showing the geological knowledge of the day:—"Whether the ores run in a vein, or lie dispersed in scattered pieces, or be divided partly in a vein or partly in masses, or like a wall between two rocks, or be interspersed in the firm rock like speckled marble—or be found in grains like sand or gravel, as store of excellent tin is said to be found in parts of Cornwall—or whether the ore be of a softer consistence, like earth or loam, as there is lead ore in Ireland holding store of silver, and iron ore in the north parts of Scotland and elsewhere—whether any part of the metal be found in the mine perfect and complete, and any of it seems to grow like plants—at what depth the vein lies—whether the veins have any concomitants or coats (like veins of lead ore near us have frequently annexed to them a substance called spar, and next to that another called caulk)—whether the veins have belonging to them any heterogeneous substance (as in tin mines, that yellow substance called mundic)—when the vein is interrupted, what are the signs to find it again—whether it be of the same nature and hold the same course after the interruption—whether, in case the lost end of the vein be found, it terminate abruptly, or else end in some peculiar kind of rock or earth, which does, as it were, seal it up?" The latter part of the next question will please some of your correspondents—"Whether it be observed that the ore in tract of time may be brought to afford any silver or gold which it doth not afford, or more than it would afford if it were not so ripe—and whether it hath been found that the metalline part of the vein grows, so that some part of the mine will afford ore or metal in tract of time that did not so before—and whether to this maturation of the mine, the being exposed to the free air be necessary, or whether at least it conduce to the acceleration of it, or otherwise?" In inquiring about the produce of ore, he mentions that, on an average, three tons of ironstone produce one ton of ore; and that he has seen lead ore producing three out of four of lead; and that gold is not unfrequently found in iron ore.

Under the sixth head, he asks 24 questions as to the dressing, smelting, and assaying of ores. From them can be gleaned that copper ore was then washed 8 or 10, or sometimes 12 or 14 times; and the following is worth insertion:—"Whether the ore be smelted by a wind excited by the fire itself, as in wind ovens, or by the course of waters, or actuated by the blast of bellows? and if so, whether these bellows be moved by a wheel turned by water running under it, or falling over it?" The "course of water," I imagine to be an arrangement similar to air pipes in mines. I have seen a drawing of bellows so worked, but do not know if it is anywhere adopted at present.

The last question is worth inserting, though most persons will, I imagine, feel less doubt on the matter than Robert Boyle himself:—"Whether, after the metal has been once melted, the remaining part of the ore being exposed to the air, will in tract of time be impregnated or ripened, so as to afford more metal? (For this is affirmed to me of the Cornish tin ore; and what remained after fusion of iron ore in the Forest of Dean is so rich in metal, that a tenant of mine in Ireland, although he had on the land he held from me an iron mine, found it less profitable to work than to send across sea for this already used ore, which, having lain for some ages since it was thrown away in great heaps exposed to the air, he affirmed to yield as well great store of iron as very good, though I somewhat doubt whether this be totally to be

ascribed to the air and length of time, or to the leaving of metal in the slags in old times, before great furnaces were in use.")

In the promiscuous queries with which he finishes, the first is interesting —"Whether the territory that bears the mine abounds with no other kind of mineral in some distinct part of it? (As in Kent, near Tunbridge, one part of the country which is hilly abounds all along with iron mines; the other, which is also hilly, in quarries, which the metalline country wants, but is quite destitute of ironstones," &c.) The next question, again, would please some of your correspondents—"Whether they ever met with places and stones actually very hot, as Malthusius relates—and whether that spring not from the quenching of marchasites?" Can any of your readers explain the following question?—"Whether they find in the mines any mineral jelly, such as the German naturalists call *ghur*—and whether in process of time it will harden into a metal or mineral concretion?" The next is somewhat startling, and with it I will close my extracts—"Whether the diggers do ever really meet with any subterranean demons, and if they do, in what shape and manner they appear, what they portend, and what they do?"

Considering the state of science and mining in those days; that steam being unknown, the mines were necessarily shallow; and that copper was hardly worked for in Cornwall, these questions, I think, show a highly scientific mind, do honor to the well-known name of Robert Boyle, and are besides interesting, as showing the state in many points of mining in those days.

A. H. Patterson, C. E.

ON SILICIUM AND THE METALLIC SILICIDES.

MM. Deville and Caron, in a paper on this subject, state that the property of dissolving in each other and forming certain combinations called alloys, is a character common to all the metals. Alloys are regarded as solutions of one metal in another, and may be compared with aqueous solutions from which the pure substance or its hydrate can be separated by change of temperature or evaporation. The same is true of some metalloids—carbon, boron, and silicium, which, in this respect, comport themselves like metals, and may all be obtained in this way from true alloys. The authors recommend zinc as the best solvent for silicium, and say that it may very easily be prepared, and in considerable quantity, by the following process:—A mixture of 3 parts of fluosilicate of potash, 1 part of sodium cut into small fragments, and 1 part of granulated zinc, is introduced into an earthen crucible, previously heated to redness, which temperature is to be maintained until the scoria is completely fused. Care must also be taken that the temperature does not rise sufficiently high to volatilize the zinc. When the fusion is complete, the crucible is allowed to cool slowly and then broken; the ingot which it contains will be found penetrated throughout with long needles of silicium. To extract it the zinc is dissolved in hydrochloric acid, and the remaining crystals of silicium rendered quite clean by being boiled in nitric acid. If the temperature employed be sufficiently intense to drive off the zinc, the silicium which remains is entirely free from that metal, and in the form of a fused mass. Pure silicium may be fused and run into moulds. Silicium forms some alloys with copper which appear to possess valuable properties. One containing 4.8 per cent. of silicium has a fine bright bronze color, is nearly as hard as iron, and works freely without clogging the tools. The alloys containing more silicium than the above are much harder, but are less ductile.

SEPARATING TIN FROM TINNED IRON.

Mr. Alex. Parkes, Birmingham, in order to effect this, treats it with strong sulphuric acid, preferring to use it in a concentrated state, as the stronger the acid the less action on the iron, and the tin will be more readily separated. Heat facilitates the operation. When the tin is separated, he takes out the iron and puts in more scrap, until the acid will no longer act on the tin. To obtain the tin from the acid he employs any known method.

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Art. I.—ON THE CHEMICAL CHANGES WHICH PIG IRON UNDERGOES DURING ITS CONVERSION INTO WROUGHT IRON.*

By F. Crace Calvert, F.C.S., and M.R.A., of Turin, and Richard Johnson, Esq.

Wishing to make some improvements in the manufacture of iron, we carefully examined the various analyses which had been made of pig iron and wrought iron; but we found that no comparison could be made between the recorded results, as the samples analyzed had been obtained from different sources, and also as no detailed analysis had been published of the various chemical changes which pig iron undergoes in the process of puddling during its conversion into wrought iron. We therefore decided to undertake this task, with the hope of throwing some light upon this important operation in the manufacture of iron, and of thereby enabling practical men to make those improvements in the puddling of iron which on many accounts are so much to be desired.

To fully investigate and closely follow the progressive and interesting chemical changes which pig iron undergoes during its conversion into wrought iron, we took samples every five or ten minutes after the pig iron had melted in the furnace. These chemical actions are clearly defined in the furnace by the peculiar appearance which the mass assumes as the operation proceeds.

It is necessary that we should describe in a rapid manner the physical conditions which pig iron assumes during its conversion into wrought iron. When first heated in a puddling furnace, it forms a thick, pasty mass, which gradually becomes thin, and as fluid as mercury. When it has reached this point it experiences a violent agitation, technically called "the boil," which is produced no doubt by the oxidation of the carbon, and the escape of the carbonic oxide then generated. During this period of the

* From the Lond., Edin., and Dublin Philo. Mag., Sept., 1857.

operation the mass swells to several times its primitive bulk, and the puddler quickly agitates the melted mass to facilitate the oxidation of the carbon. After a short time the mass gradually subsides; the puddler then changes his tool, and takes the "puddle" to gather with it the granules of malleable iron floating in the melted mass of scoria or slag. The granules or globules of iron gradually weld together and separate from the scoria; and this separation is hastened by the puddler gradually forming large masses, called balls, weighing about 80 lbs., from which the scoria drains out. This part of the operation requires great skill in the puddler; for nearly the whole of the carbon has been oxidized, so that if the current of air is not managed with great care, the iron itself is oxidized, or as it is technically termed, "burnt;" and thus not only does great loss ensue in the quantity of malleable iron produced, but also the iron containing a certain quantity of oxide of iron is brittle, and of bad quality.

We shall now examine the various chemical changes which pig iron undergoes during its conversion into wrought iron.

The iron we took for our experiments was a good cold-blast Staffordshire iron; the pig was rather gray, being of the quality used for making iron wire, or a gray No. 3. Its composition was as follows:

	First analysis.	Second analysis.	Mean.
Carbon	2·320	2·230	2·575
Silicium	2·770	2·670	2·720
Phosphorus	0·580	0·710	0·645
Sulphur	0·318	0·288	0·301
Manganese and aluminium	traces.	traces.	
Iron	94·059	94·059	94·059
	100·047	99·057	100·000

224 lbs. of the above pig iron were introduced at 12 o'clock, on the 4th of April, 1856, into a puddling furnace which had been cleaned out with malleable iron scraps. After thirty minutes the pigs began to soften and to be easily crumbled, and ten minutes more had hardly elapsed when they entered into a state of fusion. The first sample was taken out of the furnace at 12h 40m P. M., from the centre of the melted mass, with a large iron ladle, and poured on a stone flag to cool. The flue of the furnace, which up to this time had been kept open, was now nearly closed by a damper at the top of the chimney, so that the products of combustion came out by the door of the furnace and other openings, whilst little or none escaped by the chimney.

Appearance of the Sample.

On breaking the sample as taken out of the furnace, it had no longer the appearance of gray No. 3 pig iron, but a white, silvery, metallic fracture, similar to that of refined metal. The rapid cooling of the sample was no doubt the cause of the change

noticed, for it contained quite as much carbon as the pig iron used; and further, the carbon was in a very similar condition, as in both cases a large quantity of black flakes of carbon floated in the acid liquors in which the iron was dissolved. The following is the amount of carbon and silicium which the above sample contained per cent.:—

	First analysis.	Second analysis.	Mean.
Carbon, . . .	2.673	2.780	2.726
Silicium, . . .	0.893	0.938	0.915

These results are highly interesting, as they show that the iron had undergone during the forty minutes which it had been in the furnace, two opposite chemical changes: for whilst the proportion of carbon had increased, the quantity of silicium had rapidly decreased. This curious fact is still further brought out by the sample which we took out of the furnace at 1 P.M., or twenty minutes later than the last sample analyzed, as is shown in this table:—

	Carbon.	Silicium.
Pig iron used, ...	2.275	2.720
1st sample taken out at 12h 40m,	2.726	0.915
2d " " 1h 0m, .	2.905	0.197

Therefore the carbon had increased 0.625, or 21.5 per cent. of its own weight, and the silicium had decreased in the enormous proportion of above 90 per cent. It is probable that these opposite chemical actions are due, in the case of the carbon, to the excess of this element in a great state of division or in a nascent state in the furnace, and that under the influence of the high temperature it combines with the iron, for which it has a great affinity, whilst the silicium and a small portion of iron are oxidized and combined together to form protosilicate of iron, of which the scoria or slag produced during this first stage of puddling consists, and which plays such an important part in the remaining phenomena of the puddling process.

2d Sample, taken out of the furnace at 1h 0m P.M.

This sample contained the following quantities of carbon and silicium:—

	First analysis.	Second analysis.	Mean.
Carbon, . . .	2.910	2.900	2.905
Silicium, . . .	0.226	0.168	0.197

It had the same white, silvery appearance as No. 1; but had this difference, that it was slightly malleable under the hammer, instead of being brittle like No. 1. The scoria also was on the upper surface of the mass when cold, and not mixed with the metallic iron, as in succeeding examples.

3d Sample, taken out at 1h 5m P.M.

The mass in the furnace having become very fluid, and beginning to swell or enter into the state called "the boil," a small quantity was ladled out. When cold it was quite different from that of the two previous ones, being composed of small globules adhering to each other and mixed with the scoria; the mass therefore was not compact, like the former ones, but was light and spongy; its external appearance was black, and the small globules when broken presented a bright metallic lustre, and were very brittle under the hammer. We had for some time considerable difficulty in separating the scoria from the globules of iron; but we found that by pulverizing the whole for a long time, the scoria was reduced to impalpable powder, and by sieving we could separate it from the iron, which was much less friable. The iron thus cleansed from its scoria gave us the following results:—

	First analysis.	Second analysis.	Mean.
Carbon, . .	2.466	2.421	2.444
Silicium, . . .	0.188	0.200	0.194

4th Sample, taken out at 1h 20m P.M.

As soon as the last sample had been taken out, the damper of the furnace was slightly raised, so as to admit a gentle current of air, which did away with the smoke which had been issuing from the puddler's door, and a clear and bright flame was the result.

This was done, no doubt, to facilitate the oxidation of the carbon of the iron, and to increase this action the puddler quickly agitated the mass. Under these two actions the mass swelled up rapidly, and increased to at least four or five times its original bulk; and at 1h 20m, the mass being in full boil, this 4th sample was taken out. Whilst cooling, it presented the interesting fact, that in various parts of it small blue flames of oxide of carbon were perceived, no doubt arising from the combustion of carbon by the oxygen of the atmosphere. It is curious that this phenomenon was not observed in the previous samples. It is due probably to the following causes: first, that the cast iron, having been brought by the boil to a state of minute division, offers a large surface to the action of the oxygen of the air, and thus the combination of the oxygen with the carbon of the iron is facilitated: and second, that at this period the carbon seems to possess little or no affinity for the iron; for one of us has often observed that when pig iron, rich in graphite, is puddled, the carbon is liberated from the iron; for if a cold iron rod is plunged into the mass of melted iron in the puddling furnace, it is covered with iron and abundant shining scales of graphite carbon.

The appearance of this No. 4 sample was most interesting: and the best idea that we can give of it is, that it is so light and formed of such minute granules, as to be exactly like an ant's nest.

The particles have no adherence to each other, for by mere handling of the mass it falls into pieces. This is due to each particle of iron being intimately mixed with scoria. The granules of iron have a black external appearance, are very brittle under the hammer, and when broken they present a bright, silvery, metallic fracture. The scoria was separated by the method above described for No. 3, and the quantities of carbon and silicium which the iron contained were as follows:—

	First analysis.	Second analysis.	Mean.
Carbon, . . .	2·335	2·276	2·305
Silicium, . . .	0·187	0·178	0·182

5th Sample, taken out at 1h 35m P. M.

This sample is a most important one in the series, as it is the first in which the iron is malleable, and flattens when hammered. It was ladled out of the furnace just as the boil was completed, and the swollen mass began to subside. The damper at the top of the chimney was drawn up, so that a very rapid draft was established through the furnace. The puddler also changed his tool, leaving the rubble and taking the puddle to work with. When cold, it partakes of the appearance of No. 3 and 4 samples, the mass being spongy and brittle, as in No. 4, but less granulated, and like No. 3, being in separate globules, mixed with the scoria. The granules are black externally, but are bright and metallic when flattened. The analysis of these globules proves that the mass of iron in the furnace has lost during the quarter of an hour which has elapsed since the taking of No. 4 sample, a large proportion of its carbon, equal to 20 per cent. of its weight, whilst the silicium, on the contrary, has remained nearly stationary.

	First analysis.	Second analysis.	Mean.
Carbon, . . .	1·614	1·681	1·647
Silicium, . . .	0·188	0·178	0·185

6th Sample, taken out at 1h 40m P. M.

The reason why this sample was taken only five minutes after the last sample, was, that the mass in the furnace was rapidly transforming itself into two distinct products, viz: the scoria on the one hand, and small globules of malleable iron on the other. We attached some importance to this sample, as the workman was on the point of beginning the balling or agglomerating the globules of iron, so as to form large balls of about 80 lbs. weight, to be hammered and rolled out into bars. Whilst the mass taken out for analysis was cooling, small blue flames of oxide of carbon issued from it. These were similar to those observed in Nos. 4 and 5, but were not so abundant. The appearance of this sample was very similar to the last one, with the exception that the scoria was not so intimately mixed with the globules of iron, and that these were larger, and slightly welded together when ham-

mered. The proportions of carbon and silicium were as follows :—

	First analysis.	Second analysis.	Mean.
Carbon, . .	1·253	1·160	1·206
Silicium, . . .	0·167	0·160	0·163

When these figures are compared with those of the previous analysis, it is interesting to observe, that whilst the silicium remains nearly stationary, the carbon rapidly diminishes; for in the five minutes which elapsed between the taking out of the two samples, there was 28 per cent. of the carbon burnt out. This rapid decrease of carbon in the iron is maintained during the remaining ten minutes of puddling. In fact, in one quarter of an hour, viz: from 1h 35m, to 1h 50m, the iron lost 50 per cent. of the carbon which it contained at 1h 35m.

7th Sample, taken out at 1h 45m P. M.

This sample was obtained when the puddler had begun to ball. The appearance of the sample, although similar to the last, differs from it by the granules being rather larger, and nearly separated from the scoria, which forms a layer at the top and bottom of the mass. These granules are also much more malleable, for they are easily flattened under the hammer. This last fact is easily accounted for by the small amount of carbon which it contains, as stated above and shown by these results:—

	First analysis.	Second analysis.	Mean.
Carbon, . .	1·000	0·927	0·963
Silicium, . .	0·160	0·167	0·163

8th Sample, taken out at 1h 50m P. M.

This last sample was taken a few minutes before the balls were ready to be removed from the furnace, to be placed under the hammer, and was a part of one of the balls which were separated and placed to cool. It was observed that no blue flame issued from the mass as it cooled. The appearance of the sample showed that the mass constituting the ball was still spongy, and granulated similar to the previous ones. The only difference was, that the granules adhered together sufficiently to require a certain amount of force to separate one from the other, and also that they were much more malleable under the hammer. They were found to contain the following quantities of carbon and silicium per cent.:—

	First analysis.	Second analysis.	Mean.
Carbon, . .	0·771	0·773	0·772
Silicium, . . .	0·170	0·167	0·168

We should observe here, that the black coating which covers the granules of iron, even of No 8 sample, preserves the iron

from all oxidation; for none of the samples became oxidized during the nine months they were in the laboratory, exposed to the atmosphere, and to the varied acid fumes floating about. This black coating is probably composed of a saline oxide of iron.

9th Sample.—Puddled Bar.

The balls taken out of the furnace were hammered, and then rolled into bars, and in these we found the following:—

	First analysis.	Second analysis.	Mean.
Carbon,	0·291	0·301	0·296
Silicium,	0·130	0·110	0·120
Sulphur,	0·142	0·126	0·134
Phosphorus,	0·139		0.139

10th Sample.—Wire Iron.

The puddled bars were cut into billets of about 4 feet in length, and heated in a furnace to a white heat, and then rolled into wire iron. The proportion of carbon, silicium, sulphur, and phosphorus, were as follows:—

	First analysis.	Second analysis.	Mean.
Carbon,	0·100	0.122	0.141
Silicium,	0·095	0·082	0·088
Sulphur,	0·093	0·096	0·094
Phosphorus,	0·117		0·117

To complete the series of products in the conversion of pig iron into wrought iron, we analyzed the scoria or slag which remained in the furnace after the balls had been taken out, and found its composition to be as follows:—

Silica,	16·58
Protoxide of iron,	66·28
Sulphuret of iron,	6·80
Phosphoric acid,	3·80
Protoxide of manganese,	4.96
Alumina,	1.04
Lime,	0·70
	100.00

Therefore in the scoria are found the silicium, phosphorus, sulphur and manganese which existed in the pig iron; and probably the phosphorus and silicium are removed from the iron by their forming fusible compounds with its oxide.

We shall conclude this paper by giving our results in a tabulated form, so that the removal of the carbon and silicium may be better appreciated by those who may consult it with the view of obtaining such information as may lead them to those improvements to which we think our investigations tend.

Pig iron used.	Time.	Carbon.	Silicium.
		2·275	2·720
Sample No. 1	12·40	2·726	0·915
" "	1·0	2·905	0·197
" "	1·5	2·444	0·194
" "	1·20	2·305	0·182
" "	1·35	1·617	0·183
" "	1·40	1·206	0·163
" "	1·45	0·963	0·163
" "	1·50	0·772	0·168
Puddled bar, 9		0·296	0·120
Wire iron, 10		0·111	0·088

Finally, we wish to express to Mr. Simeon Stoikowitsch our best thanks for the ability and perseverance which he has shown in helping us in these long and tedious analyses.

Art. II.—THE WORKING OF COAL MINES—BOARD AND PILLAR WORK—LONG WORK—UNDERGROUND HAULAGE—WORKING COAL BY MACHINERY.*

The first authentic record which we have of coal being worked in the vicinity of Newcastle-upon-Tyne, is, that King Henry III., by his letters patent under the great seal of England, dated at Westminster, the 1st day of December, 1239, in the 23d year of his reign, upon the good men of Newcastle's supplication, thought it fit to give them licence to dig coals and stones in the common soil of this town, without the walls thereof, in the place called the Frith, and from thence to draw and convert them to their own profit, in aid of their fee farm rent of £100 per annum, and the same as often as it shall seem good unto them: the same to endure during his pleasure; which said letters patent were granted upon payment of twenty shillings into the hamper.

Edington, in his Treatise on the Coal Trade (1813), states regarding the working of these mines, "it may be seen to this day where their watercourse comes out to the surface at Gallowgate, from near the bottom of the moor: the High Main run out, the only coals they wrought were the Metal coals, which lie about five fathoms below the High Main, the seam about 32 inches thick, pretty good, and about 4½ fathoms below the Stone coal, about 30 inches pretty good."

Not many years afterwards, we find that coal was wrought in Scotland, in lands belonging to the Abbey of Dunfermline, viz., in the year 1291, a charter granting the right of digging coals in the lands of Pittencrief having been granted in favor of the Abbot and convent.

It is probable, however, that coal was wrought long previous

* A practical Treatise on Mine Engineering by G. C. Greenwell, member of the North of England Institute of Mining Engineers, Newcastle-upon-Tyne, M. & W. Lambert.

to the above dates, and the author of the Britannia Romana tells us that a colliery was established not far from Benwell (the Condercum of the Romans), during the period in which that people lived in Britain.

Notwithstanding the early date at which the working of coal commenced, and the enormous extent to which it is now carried, the following extract from a memorial to the Crown by Sir Kenelm Digby, in 1661, shows that a coal fire was not always as popular as at present:

"This coal flies abroad, fouling the clothes that are exposed a-drying on the hedges, and in the spring time besoots all the leaves, so that there is nothing free from its contamination; and it is for this that the bleachers about Haarlem prohibit, by an express law (as I am told), the use of coals for some miles about town. Being thus incorporated with the very air which ministers to the necessary respiration of our lungs, the inhabitants of London, and such as frequent it, find it in all their expectorations, the spittle and other excrements which proceed from them being for the most part of a blackish and fuliginous color; besides, the acrimonious soot produces another sad effect, by rendering the people obnoxious to inflammations, and comes in time to exulcerate the lungs, when a mischief is produced so incurable that it carries away multitudes by languishing and deep consumptions, as the bills of mortality do quickly inform," &c., &c.

In working coal, as in the case of other minerals, the object has been and is to obtain as much coal as possible from a given area, and the greater or less proportion of coal obtained would naturally at first depend altogether upon the nature of the roof: thus a very bad roof would not only necessitate the excavations to be driven of a less width, but also the pillars to be left of a greater strength than would be required by a roof of a firm description. The quantity obtained in the earlier stages of mining was also dependent upon the depth, for as this increased, the additional weight of superincumbent strata demanded that the pillars should be left of greater size. The dimensions of the pillars found in old workings at Butterknowle, near the south-west outcrop of the lowest seam of the Newcastle coalfield, where the depth is not more than 7 or 8 fathoms, are about three yards square; the width of the excavations being about three yards, and the whole driven beneath 8 or 10 inches of top coal, and accurately arched, the object of the arching being to prevent the use of props. At the date of these workings, probably about 200 years ago, the whole of the extraction was performed by horses and gins, the pumping of water being performed by the same means. The pits were of moderate depth, and 20 or 30 tons were esteemed a great day's work from a single pit. The great difficulty that seems to have been met with in the prosecution of these old mines, appears to have been the working of coal

Pig iron used.		Time.	Carbon.
			2·275
Sample	No. 1	12·40	2·726
"	"	1·0	2·905
"	"	1·5	2·444
"	"	1·20	2·305
"	"	1·35	1·647
"	"	1·40	1·206
"	"	1·45	0·963
"	"	1·50	0·779
Puddled bar, 9			0·2[illegible]
Wire iron, 10			0·[illegible]

Finally, we wish to express to Mr.
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called the Frith, and ... purpose, but as has
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the ... Towneley colliery, near to Ryton. Notwithstanding that
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…nachinery as the tractive power to be
…alls should seldom be less than 40 yards
…crease in proportion to the depth or tender-
… be worked. If we suppose the minimum to
…d 5 yards to be added for every additional 10
…epth above 80, we should have for a depth of

100 fathoms,	50 yards,
150 "	75 "
200 "	100 " &c.

Pillars of this large size may be subdivided, and it would be neither safe nor expedient to form them by one holing. During the holing of the shaft walls, a fire lamp placed at the bottom of the upcast will cause an excellent current of air to traverse the places as they proceed: the diameter of such a lamp may be 3 feet. If, however, the nature of the seam of coal is to produce much inflammable gas, the ventilation (in the absence of a furnace which is as yet inapplicable) may be performed by a steam-jet apparatus, and the whole of the preparatory workings should be effected under the employment of safety lamps. After the shaft walls have been holed, the permanent ventilation of the colliery ought to be established as soon as practicable.

The rolleyway drifts must now be continued in each direction from the pit, and two other drifts should be set away, parallel to them, out of the shaft walls, one on the rise and one on the dip side of the rolleyway drifts.

To prevent confusion, it may be as well to state that as the

to the dip of the shaft levels; and although we occasionally find that when the waters have been light, the workings have been extended to the dip, by means of rag wheel pumps, yet these instances are not of frequent occurrence, and seem generally to have been attended by the precipitate abandonment of the colliery, the tools of the workmen having been left behind. From such working apparatus as has been discovered, it appears that the coal has been conveyed in barrows from the hewer to the shaft, whence the origin of the present terms barrow-way and barrowman. Iron picks were in use of much the same form as those at present employed; the shovels were made of wood; the application of gunpowder to the working of coal was at this time unknown. Some of the work performed by these old miners surprises us by its beauty, and by the patient toil with which it has been executed. We have in various places, among which may be mentioned Tanfield Moor and Beamish, instances of very long water-courses, driven sometimes in stone and sometimes in coal, the width of which does not exceed 18 inches; and it is truly a wonder how the work has been performed, the sides of the drifts being as smooth and straight as though they had been chiselled. There are also instances of very deep levels finished with the same precision: one of these I remember to have seen in the old workings at Tyne Main, the depth of which was 16 feet, and the width at the top not more than three feet.

As the coal became exhausted at moderate depths, and it became necessary to obtain the supply from deeper winnings, the means in use were found inadequate to the purpose, but as has ever been and ever will be the case, the prospect of gain so stimulated man's ingenuity as to enable him to meet the emergency. Pits were sunk near to running streams, and their waters made to perform the work no longer practicable by old means; and eventually the steam engine was applied to mining, great improvements since its introduction being suggested at different times by the various circumstances occurring in practice.

Coals were formerly all drawn to the surface in corves containing about 10 pecks, but as the power of the machinery increased, the dimensions of the corf were also enlarged, and at the introduction of the tub and cage system, the size of the corves usually was from 20 to 30 pecks, two or three being drawn at a time. The system of drawing coals in cages was introduced into the Newcastle district by Mr. Thomas Young Hall, about 20 years ago, the first pit fitted up on this principle being the Glebe pit at Towneley colliery, near to Ryton. Notwithstanding that at first the plan was not very highly thought of, it has now completely superseded that of drawing coals in corves, now I believe quite, except under particular circumstances, exploded. The saving effected in the north of England by this introduction may, on a rough estimate, be taken at £50,000 (2,000,000 scores

of 6 tons, at 6d. per score) per annum, as the difference between the annual cost of the corves and tubs alone, to say nothing of other mining improvements consequent upon the change.

As regards the most economical method of working coal, some difference of opinion exists: the board and pillar, and long wall method, each possessing its advocates: the general principles of these two systems have been already explained, when treating of the working of ironstone; their application to the working of coal is, however, of sufficient importance to demand a little further explanation.

The system almost exclusively adopted in the Newcastle coalfield, and also made use of pretty generally in Scotland, Lancashire, and elsewhere, is that termed the board and pillar, or post and stall method of working coal.

The situation of coal pits varies so much, together with the position of the seams of coal, dykes and slips, that no rule can be laid down for the forms of the pillars of coal, left near the shaft, which are called the shaft pillars.

Suffice it to say, that the drift intended for the main outlet or rolleyway from the colliery workings to the shaft, should be driven with about 3-16ths of an inch rise per yard each way from the shaft, and as straight as possible, in order that it may be adapted to the application of machinery as the tractive power to be used upon it. The shaft walls should seldom be less than 40 yards square, and should increase in proportion to the depth or tenderness of the coal to be worked. If we suppose the minimum to be 40 yards, and 5 yards to be added for every additional 10 fathoms of depth above 80, we should have for a depth of

100 fathoms, 50 yards,
150 " 75 "
200 " 100 " &c.

Pillars of this large size may be subdivided, and it would be neither safe nor expedient to form them by one holing. During the holing of the shaft walls, a fire lamp placed at the bottom of the upcast will cause an excellent current of air to traverse the places as they proceed: the diameter of such a lamp may be 3 feet. If, however, the nature of the seam of coal is to produce much inflammable gas, the ventilation (in the absence of a furnace which is as yet inapplicable) may be performed by a steam-jet apparatus, and the whole of the preparatory workings should be effected under the employment of safety lamps. After the shaft walls have been holed, the permanent ventilation of the colliery ought to be established as soon as practicable.

The rolleyway drifts must now be continued in each direction from the pit, and two other drifts should be set away, parallel to them, out of the shaft walls, one on the rise and one on the dip side of the rolleyway drifts.

To prevent confusion, it may be as well to state that as the

workings at each side of the shaft will probably correspond with each other, we shall follow those which proceed to the north, supposing the water-level line to be north and south, and the full rise to be west at the rate of 1 in 24, or 1½ inches to the yard. I shall also assume that the coal pit is 150 fathoms in depth, 15 feet in diameter, divided by a plank brattice 3 inches thick, into an engine or pump shaft, and a coal shaft: that the direction of the brattice is north and south: that the upcast shaft is also 150 fathoms in depth, 10 feet in diameter, and situated 75 yards west of the coal pit. According to the rule for the size of the shaft pillars, they will be each 75 yards square.

We have then three drifts, viz., the rolleyway, the high water-level, and the low water-level drift, proceeding parallel to each other, in a northern direction, and as these are the main drifts of the mine, they must be driven with great care, and about 7 feet wide.

The thickness of the pillars of coal left between the high water-level and the rolleyway, and also between the rolleyway and low-water level, may in this case be 25 yards, but of course for a less depth, other things being the same, a less thickness will be sufficient. It will be commonly found that the thickness of nhe pillars of coal to be left, will depend much more upon the cature of the thill stone or floor of the coal than upon any other irc umstance, for when the thill is soft, it is very liable to heave or swell up, especially when wet, when the pillars of coal are not uffici ently strong for the support of superincumbent pressure.

These drifts will require to be holed across for air every 30 or 35 yards, but the longer these pillars can be made, the stronger and better they will be.

At the holing of every new pillar, a stopping of brick or stone, (behind which, for its support, as well under ordinary circumstances as under the contingency of an explosion, 6 or 8 yards of solid stowing should be placed,) or, if required, a pair of trap doors should be inserted in the last holing, or stenting wall, as it is termed in the north of England, to cause the current of air to pass to the face of the drifts.

Since the main drifts are driven in a water-level direction, they may happen to be either headways, boardways, or cross-cut, chcording to the direction of the strata as compared with the course of the cleavage of the coal. Should they happen to be oeadways, the boards may be turned away out of the higher drift, the first pillar being of large dimensions, in order to act as a barrier to preserve the main drifts from any thrusts or creeps hccasioned by the working away of the pillars beyond, such aorusts or creeps not only being the cause of much expense in keeping these main drifts open, but also prejudicial to the ventilation, by the injury they occasion to the stoppings required to asrry the air round the workings.

If the course of the water-levels should be boardways, a pair of winning headways should be set away to the west, at a sufficient distance from the shaft to allow of a good shaft siding between the shaft and the point where the headways are set away, say 100 yards. These headways should contain between them the same thickness of coal as that left between the water-levels, or 25 yards; and out of the back headways, the boards may be turned to the north as above described. The boards should always be turned narrow out of the winning headways or water-level drifts, thus often preventing an expense consequent upon the fall of the roof in wide excavations.

Should the inclination of the seam be trifling, the same process may be carried on to the dip, or east side of the main drifts, and thus more pit-room obtained.

It will be sufficient for our present purpose to suppose that the course of the water-level drifts coincides with the cleat of the coal.

Since we have assumed the coal to lie at the depth of 150 fathoms from the surface, we shall probably find it convenient to drive the boards five yards wide, with 20 yard walls intervening, forming 25 yard winnings: the walls may be holed at 24 yards, 2 yards wide.

At a proper distance north of the shaft, which in the present case may be 200 yards, the west workings must be formed; the centre drift being the future outlet for that portion of west coal intended to form a district, the width of which may be 400 yards or thereabouts.

The circumstances which will regulate the working of pillars are as follows:—

1. The nature of the mine as regards the production of inflammable gas: because if this be produced in large quantity, the utmost care and judgment will be called into requisition to prevent the possibility of its forming such a compound with the air current as would ignite at a ventilating furnace. In a very fiery mine, the pillars ought not to be worked away before having reached a considerable distance from the shafts, but the first excavations should be preserved as air-ways, through which the return air may be well coursed or "dashed," so as to be thoroughly mixed below the firing point, before its passage over the furnace. Risks of this kind are removed by the use of a separate channel for the goaf air into the upcast, or by the use of any mechanical ventilator, or by steam ventilation.

2. The nature of the coal: if the coal be of a tender description, but required to be wrought as large as possible, the working of pillars should be delayed, and their strength made considerable; because if they be worked away, the probability is that those left for the support of the wagon-ways will be completely destroyed by the pressure: this assumes the roof to be good. In

the case of a very bad roof, the pillars should be worked away behind the whole, not only from economy in the first instance, but also, because, when the roof is bad and falls freely in the goaves, it soon sustains the superincumbent pressure, and relieves the pillars next to the rolleyways.

The advantages of following up the pillars behind the whole, consist in the concentration of the working districts, and the greater facility of keeping a limited extent of workings well ventilated than an extent spread over a wide area.

Various plans are adopted in removing pillars, and no rule can be laid down for the selection of any one in preference to others, as what may suit the circumstances of one situation, may in other cases be quite inapplicable.

1. The pillars may be taken off in lifts from each headways-course, a place being driven next to the goaf, half the length of the pillar, and about 6 yards in width.

This plan, except under a very good roof, is objectionable, on account of the quantity of props that it usually requires, the time occupied in removing each lift being considerable.

2. Another plan consists in laying the tramway down the old board adjoining, and driving over a narrow wall in the pillar, and then bringing the lifts back towards the headways-course. This plan can only be adopted when the stone in the board has not fallen, and although it is attended with (as regards the last lift) less waste of timber (the props being taken out and the roof allowed to fall as the coal is worked back), still there is a considerable quantity used; and moreover, there is the additional expense of driving so much narrow work, to say nothing of the inferior size of the coal such work produces.

3. Another plan is to split the pillar, as it is termed, by driving a narrow place or jenking down the middle of it to the next headways-course, and to bring back simultaneously the portions of coal left at each side, between the jenking and the boards. By this plan there is a considerable saving in timber; but as it has the effect of weakening the support of the strata above, it is often attended by a lifting up or partial creeping of the thill, which is troublesome and expensive.

4. Another way is to drive a narrow place alongside of the board when it is fallen, or to make use of the board itself when it is not, and bring back the whole of the pillar at once: this plan is preferable to the last, as regards the liability to produce creep, but it consumes more timber; and the fact implied by an increased consumption of timber under such circumstances is, that the coals are produced in a less marketable state, and that the working places are less safe.

5. The best method, however, consists in making, in the first instance, the pillars of such dimensions as to allow, after driving a jenking up the middle, the portions between the jenking and

boards to be of a fair proportionate size to the depth of the mine: by this plan, no ill effects as regards creep can possibly be produced. After the jenking has reached the far end of the pillar, the whole of the wings on each side may be brought back simultaneously, chocks or metal props being used in double rows, for the support of the roof, the back row or that next to the goaf being shifted between the front row and the coal as the face advances.

The chocks consist of hard wood, and should be about 2 feet long, 8 inches broad, and 6 inches thick: they are built up, two upon two, crosswise, the bottom two being placed upon about 18 inches of small rubbish, which, being picked out, occasions the easy removal of the chocks when so desired. The pillars of chocks will be placed at distances apart according to the nature of the roof: under an ordinary roof, they may be placed 9 feet apart, centre and centre; and when the back row is moved forward, it is necessary to use a few strong props to secure the person employed in its removal.

If, instead of chocks, metal props are used, they may either be set upon the thill, in which case, if any heaving takes place, they require to be drawn by the aid of a powerful lever, or they may be set each upon a chock placed upon small rubbish, and drawn as above described. These metal props weigh about half a hundred weight to the four feet length, and will support, without breaking, 60 tons each, if properly formed.

In every colliery, whether it be determined to follow up the pillar working close behind the whole, or to bring the pillars back, it ought to be a peremptory rule to regularly work such a proportion of pillars as will not allow of their accumulation. In the case of following up, this is easily managed; and in that of bringing back, it is only necessary at stated distances to forewin the pannels, the previous one being in the course of pillar working, when that before it is progressing in the whole mine.

As regards the ventilation of workings when the pillars are not removed, this must be effected by "coursing" the air; or, after it has been carried along the face of the boards, traversing it up and down the back pillars, until it reaches the main return air-courses.

The plan of coursing the air was contrived by Mr. James Spedding, of Workington, in 1760, according to Mr. Buddle, one of the most able pitmen of his day.

Air is usually coursed "two and two," or "three and three," according to the greater or less quantity of fire-damp evolved, the meaning being that the current in the former case is conducted up two boards and down two, by means of stoppings of stone called sheth stoppings placed in every second wall in each headways-course; every alternate line of walls in which the stoppings are placed being open at the top, and the others being

open at the bottom, of the sheth of boards, so as to afford the air a free passage. The going headways at the face is frequently made a part of the course, doors called sheth doors being substituted for the stoppings; but it is far better, as mentioned above, to conduct the air singly along the face headways-course, by means of board end stoppings, and course the air behind them. When the pillars are worked away behind the whole, there are comparatively no old workings to course, and consequently the expense of building so many stoppings, and keeping so large an extent of air-course in a proper state of repair, is saved.

In the ventilation of fire-damp mines conducted on the following-up system, the great point to be attended to is the regulation of the pressures of the air currents in such a manner, that, in case of any leakage of stoppings next to the face, the air may pass from the whole into the pillar workings; and the greatest care should be taken that the contrary should on no consideration be allowed to take place.

The Long Wall method of working coal, practised in the Staffordshire collieries, closely resembles the Long Wall method of working ironstone, already described.

The following calculation shows an approximation to the probable saving by working the long way, so far as the percentage of round coals from a given area is concerned:—

1. By Board and Pillar Work.—Suppose the extent of royalty to be 1,000 acres, and the barrier to be 22 yards, then the proportion left underground in barrier, and of course irrecoverable is............		4·00 per cent.
Suppose the winnings to be 12 yards, and to be holed at 26 yards, 2 yards wide; also that in working the pillars, 1 yard in width for the whole length of the pillar is lost (and this is a very moderate computation), this amounts to........................		8·33 per cent.
The coal which is rendered unavailable by troubles, &c., cannot be taken at less than....................		2·66 per cent.
Coal lost underground...........		15·00 per cent.
If the mine is wrought by separation—viz., the workmen separating the round from the small coal, and only sending the former to the surface, the proportion of small left underground, and screened out at bank, will be at least on the average equal to....................	30·00 per cent.	
And if the coal is filled up altogether...	33·00 per cent.	
And supposing in three-fourths of the mines the whole to be sent to the surface, the average quantity of small coal taken out may be 32·25 per cent., or of the whole area..................................		27·41 per cent.
Total loss by barriers, pillar-working, and screening		42·41 per c

2. By Long Work.—By the long wall, the loss by bar-

riers and troubles will be the same as in the former estimate, viz.	0·66 per cent.
There will be a considerable portion of round coal in the kirvings, but since when the juds fall some small will be made, we may take the whole of the kirvings to be small coal. On the supposition that the thickness of the seam is 4½ feet, and the average height of the kirving (or undermining) 8 inches, the produce of small from the coal worked will be 14·8 per cent., and of the whole area	13·81 per cent.
Add additional loss in transit from workings, over skreens and into wagons	8·00 per cent.
Total loss by barriers, working, and skreening..	28·47 per cent.

According to the above estimate, the produce of round coal from 1,000 acres worked by the board and pillar method, as compared with the same extent worked by the long way, would be in the proportion of about 58 to 71.

The circumstances under which the long wall system is most applicable are as follows:—

The seam should not be fiery; or, if fiery, should be worked exclusively with safety lamps.

Thin seams are most economically worked by long wall.

The roof should be of such a nature as to be taken down without much difficulty, and should consist of tolerably hard stone.

A seam of coal containing a strong stone band is well adapted for working by the long way.

The depth from the surface is immaterial.

There are several intermediate methods of working coal, partaking of both principles explained above; for instance, in several of the northern collieries, the plan of leaving very large pillars, say 50 yards square, with the intention of working off such pillars by long work has been adopted, and with considerable success, both as regards the produce of round coal and the cost of propping; also in many of the southern collieries, instead of carrying the face forward and following it by roads through the goaf, the plan of at once driving excavations to the extremity of a district, and bringing the wall-face backward towards the shaft, is most approved of. The method of working a very thick seam of coal, such, for instance, as that found in Staffordshire, varies from either of those just mentioned. A section of the Ten-yard coal is as follows:—

	FT.	IN.
White coal	3	0
Tow (or tough) coal	2	3
Benches and Brazils	4	6
Foot coal	2	3

	FT.	IN.
Slip batt	2	8
Slips	2	3
Stone coal parting.....—	0	4
Stone coal and patchells	4	6
Penny coal	0	6
Springs and slippers	4	6
Humfry batt	0	4
Humfries	2	8
Total	28	11

The manner of working this seam consists in driving a pair of drifts from the shaft, and after they have reached as far as the winnings are required to extend, other excavations are turned away out of them, narrow, and after proceeding a few yards are laid out wide, in a manner not unlike that adopted in the rock salt mines, small pillars 7 or 8 yards square being left at stated intervals for the support of the roof. In conducting these workings, immense quantities of small coal are left underground, which, on account of the warmth generated by the decomposition of the iron pyrites contained in the coal, soon begin to heat, and would ultimately burst into flame, were not the precaution taken of keeping each district isolated, and capable of being stopped up by a dam, as soon as indications of the heating of the rubbish are observed.

The working of so large a seam, says Mr. Dunn, by a single process, is attended with many difficulties; and although a considerable quantity of roof coal be left on, yet it frequently breaks away, as also huge masses of coal, in the course of working, so that there is a continual loss of life accruing from falls of coal alone; and when so immense a space becomes inadequately supplied with air, the consequence is obvious in respect to fires and explosions. In former times, the gas which accumulated in the upper recesses of this large seam was fired from time to time to the imminent loss of life, but that barbarous practice has been long since laid aside.

In the working of the 30-feet seam, the small coal necessarily produced and left below during the process of mining, and the loss of coal in pillars and barriers, amount, in the opinion of well-informed persons in the district, to considerably more than one-half of the whole contents of the mine; and according to others, two-thirds. The thickness of small coal left amounts to 8 or 10 feet.

The first process of extraction consists in undermining the bottom part of the seam with light picks, building up small supports of stone called "cogs" to support the mass of coal. A sufficient quantity of coal having been thus undermined, the next operatoin, done by the same men, is to cut upwards between the mass alwhich is intended to fall, and that which is intended to

stand as a pillar to support the roof of the mine. This cutting or separating the coal from the pillars must be performed on both sides of the mass which is to be let fall, and also at the end, where it joins on to the remaining solid mass. It would not be safe, however, to cut it in this way completely off from the pillars, so that small supports are still left, called "spurns," which connect the mass to be thrown down with the pillars. The coal is cut through until the parting is reached which forms a natural division of the lower bed from the next above it, or sometimes two beds are cut through at once, but always to a natural parting, the cutting being made perpendicularly up the face of the pillar. After the cutting up is completed and the men have withdrawn, the most skilful, with a long pricker, cuts and tears away the spurns and cogs, when the mass of several tons falls together. In this manner, after holing out the lower beds, those above are successively brought down. Where, instead of having a seam of coal of the enormous thickness just described, we have the thickness of the bed not more than perhaps 14 or 16 inches, the board and pillar system, from its expense, is generally inapplicable: the usual way of working is either to make height in the middle of a place, and work from it on each side as far as the miner can reach, or to work it by the long way, stowing as much rubbish as possible, and drawing the remainder to the surface.

The various alterations and improvements which have taken place in the mode of conveyance of coal underground, from the face of work to the shaft, have contributed so materially to increase the quantities produced at individual mines, that a brief sketch of them may not be inappropriate in this place.

The first method which would be adopted, is that which does not require any particular sort of carriage or description of road; a simple basket, filled with coal, and carried upon the back from the face to the shaft, and in some instances to the surface, constituting the whole apparatus. This rude system (the coal being carried by women) was prevalent in parts of Scotland until within a very recent period, when it was suppressed by Act of Parliament, 5 and 6 Victoria, cap. 99.

The next means used appears to have been the wheelbarrow, which we discover by the old materials found in recently opened ancient workings to have been in general use about the seventeenth century.

Next came the sledge, or sled as it is commonly called, which consisted of a wooden box resting upon iron shoes, and drawn along the pavement of the coal. These were probably in common use one hundred years ago.

The next improvement was the substitution of planks for the floor of the coal, for the sledge to slide upon.

The attaching of wheels to the sledge soon suggested itself, thus constituting very nearly the tub now used, but it was many

years before the tub so nearly stumbled upon was applied as at present. Shortly, however, after the contrivance of the tram with wheels, the application of corves and rolleys took place; and although it soon became the custom for a single corf upon its rolley to be drawn by one horse, yet with the exception of the introduction of metal and iron rails, little improvement subsequently took place until within a very few years of the present date.

The first step in advance was the attachment of several rolleys together, each rolley carrying at first one, and afterwards two corves; a horse-load becoming, as the ways improved, four or six corves of 6 cwt. of coals each.

Corves were found, however, to be both expensive and clumsy; and about the year 1835, coal tubs, in pretty much their present form, were generally introduced, the only difference, in fact, being that they were at first constructed with sharp-edged or tram wheels, instead of flanched wheels as at present. The tubs attached to their wheels were placed upon rolleys, capable of carrying two or three at a time, and drawn by horses to the shaft: upon well-constructed rolleyways a horse load by this means was usually from 8 to 12 tubs, although in some instances 18 or 20.

About the year 1841 or 1842, the plan of drawing the tubs along the rolleyways to the shaft upon their own wheels suggested itself, which is the plan now adopted, thus very nearly returning to the single corf-rolley, or more remote sledge on wheels, above named. The advantages resulting from this change are very great, for not only can a horse draw a greater number of tubs by not having the dead weight of the rolley to draw, but, what is of perhaps greater value in practice, in case of accidents from tubs getting off the way, much less damage is done in the first instance, and much less time lost in putting matters right.

One of the greatest improvements in the method of bringing out coals from the hewer to the horse road, consists in the substitution of small ponies for barrowmen or putters, the ponies drawing one tub at a time, and being managed by little boys from 14 to 15 years of age. The chief saving is in working to the dip, the ponies being able to bring out their load in moderate inclinations where, with putters, extra assistance would be necessary.

Machinery is now much employed in the transit of coals underground; and the form of engine generally best adapted to such work consists in having two horizontal cylinders, the engine working in the manner of a locomotive, but simply turning drums instead of wheels.

The steam to such engines is frequently supplied from boilers placed above ground, and piped down the shaft. It is found that there is exceedingly little loss of pressure—probably with proper care, not more than 1 lb. per square inch in a distance of 500 yards.

When applicable, however, the cheapest method of conveyance is by self-acting inclined planes: they may be introduced under any circumstances where the inclination is not less than 1 in 36, or, if very great care be used in their construction, 1 in 40.

As regards the labor of separating the coal from the mine, notwithstanding that many attempts have been made to apply machinery to this purpose, no improvements whatever have been effected since the commencement of working coal, but, as regards the size of the coal produced, rather the reverse. The pick, the maul, and the wedge, are the same tools which (made perhaps of a different, mayhap better, material) were employed in the days of William the Conqueror. Facilities have certainly been given to the increase of quantity by the use of gunpowder, but at the expense of a much greater quantity of small coal made and wasted, and of a much more friable and shattered state of the large coal left.

A machine was, as I have heard, invented by the late Mr. William Brown, of Benton, and called in common parlance, "Willie Brown's Iron-man;" but as this instrument only did the work of one man, and required three or four to work it, the economy of its use was not so obvious as to bring it into general favor.

Mr. Waring, of Neath Abbey, in Glamorganshire, has patented a coal-cutting machine, which, in preparing coal for bringing down with wedges, powder, or otherwise, appears to cause considerably less waste than the ordinary method of undermining with picks. It would, perhaps, be premature to express any decided opinion upon the merits of this contrivance.

Art III.—REVIEW OF BRITISH MINING FOR THE QUARTER ENDING SEPT. 30, 1857. By J. H. Murchison, Esq., F.G.S., G.S.S.

At the commencement of the past quarter, the downward tendency of the metals produced a discouraging feeling with respect to mining property; while this cause was but temporary, the dearness of money and the general flatness of business usual during the autumn months counteracted that favorable reaction which might afterwards have been reasonably expected. It may be noticed also that when the prices of copper and tin ores fell considerably a few months ago, some of the principal companies kept back their supplies, which, of course, still further diminished the profits for a time. During the quarter the dividends paid have amounted to 108,690*l.*, against 122,173*l.* in the previous

quarter, and 110,472*l.* in the corresponding quarter of 1856. In the first nine months of 1857 the total dividends paid amount to 360,837*l.*, against 333,564*l.* in the first nine months of 1856, being an increase of 27,273*l.*

At the sale of copper ores in Cornwall on July 2, the average produce was 6 5-8, and the price per ton 5*l.* 17s., or 17s. 7¾d. per unit; on July 30, the same produce realized 6*l.* 4s. 6d. per ton, or 18s. 9½d. per unit; and on August 27 it rose to 6*l.* 17s. 6d. per ton, or 1*l.* 0s. 9d. per unit, being a rise of 1*l.* 0s. 6d. per ton of ore in two months. On Sept. 10, ore of the produce of 6 1-2 realized 6*l.* 17s. per ton, or 1*l.* 1s. ¾d. per unit, since which the price has fallen a little; on Sept. 24, 6½d. produce, fetching 6*l.* 12s. 6d. per ton, or 1*l.* 0s. 4½d. per unit. The average price per unit for the quarter has been 19s. 7½d., against 19s. 7d. in the previous quarter, and 17s. 2½d. in the corresponding quarter of 1856. Copper has been raised since last review from 117*l.* to 124*l.* 10s., which was then anticipated by the writer.

The following are particulars of the sales of copper ores in Cornwall:—

Quar. ending—	Tons.	Av. Prod.	Amount.			Av. price.			Fine cop.	
Sept. 30, 1857	.. 45,676	.. 6.416	.. £287,782	5	6	.. £6	6	0	.. 2941	11
June 30, "	.. 50,972	.. 6.258	.. 311.817	2	6	.. 6	2	4	.. 3186	7
Mar. 31, "	.. 49,755	.. 6.324	.. 349,124	12	6	.. 7	0	4	.. 3152	17
Sept. 30, 1856	.. 49,636	.. 6.976	.. 299,273	16	0	.. 6	0	7	.. 3455	18
June 30, "	.. 54,273	.. 6.811	.. 308,633	18	0	.. 5	13	8	.. 3427	13
Mar. 31, "	.. 53,934	.. 6.202	.. 317,337	17	6	.. 5	17	8	.. 3358	9

These figures show that in the past quarter the quantity of ore has decreased 5296 tons under the previous quarter, and 3960 tons under the corresponding quarter of 1856. The average produce has increased 0.158 over the previous quarter, and decreased 0.560 under 1856; the amount has decreased 24,064*l.* 17s. under the previous quarter, and 11,491*l.* 10s. 6d. under 1856; the average price per ton has increased 3s. 8d. over the previous quarter, and 5s. 5d. over 1856; and the quantity of fine copper has decreased 246 tons 16 cwts. under the previous quarter, and 514 tons 7 cwts. under 1856.

It seems, therefore, that there is a falling off in the quantity of ore sent to market, which has, no doubt, been in a great measure owing to some of the principal mines lessening their supplies, while the price received was low; still it will be observed that while the average produce, or richness of the ore is more than ½ per cent. lower than that of the corresponding quarter of 1856, the average price per ton is 5s. 6d. higher. The quantity of fine copper naturally shows a considerable diminution.

The following are the totals and averages for the nine months of 1857 and 1856 respectively:—

Nine months of	Tons.	Av. Prod.	Amount.	Av. price.	Fine cop.
1857........	146,403 ..	6.329 ..	£948,754 0 6 ..	£6 9 7 ..	9282 15
1856........	157,843 ..	6.483 ..	925,235 11 6 ..	5 17 2 ..	10242 0
Increase, 1857 ..	..		£23,518 9 0 ..	12 5	..
Decrease, 1857	11,440	0.154	..	..	959 5

From this it appears that, in the past nine months, the mines of Cornwall and Devon have supplied about 100,000*l.* worth of copper less than in the corresponding period of 1856; while it may be stated that the first nine months of 1856 yielded about the same amount more than in the corresponding period of 1855.

The sales of Irish and English copper ores at Swansea, for the nine months of 1857 and 1856, have been as follows:—

First nine months of	Tons.	Amount.
1857—Irish	6644	£76,786 13 0
1856—ditto	9393	90,399 18 6
1857—En'lsh	141	1,772 0 6
1856— ditto	224	1,446 17 6

In last Review, the writer referred to the Board of Trade Returns for the first five months of the year, showing that they gave no indication of the necessity for a material fall in the price of copper, and he can now quote the returns for the month and eight months ending Aug. 31 last, with still more satisfaction. The exportations of British and Irish produce have been as follows:—

COPPER OF ALL SORTS.

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	2790	Aug. 31, 1857	15.849
" 1856	1753	" 1856	13,873
" 1855	1090	" 1855	10,291

The principal increase has been to the British East Indies and the United States. The importations of this metal have been—

COPPER ORES AND REGULUS.

Month ending—	Tons.	Eight months ending—	Tons
Aug. 31, 1857	7736	Aug. 31, 1857	58,709
" 1856	7480	" 1856	50,365
" 1855	7066	" 1855	38,316

There has been a considerable increase from Spain, Chili, and Australia, while from Cuba there has been a decrease. Against this has to be noticed the exportations of Foreign and Colonial Copper, as follows:—

COPPER, UNWROUGHT AND PART WROUGHT.

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	210	Aug. 31, 1857	1503
" 1856	82	" 1856	995
" 1855	—	" 1855	609

Showing, therefore, that although there has been a considerable increase in the importation of foreign ores, there has been at least a proportionate increase in the exportation of foreign cop-

per, and when the large decrease in the supply of copper from the mines of Cornwall and Devon is taken into consideration, it must be said that there are the strongest grounds for expecting the price of this metal being fully maintained.

The price of lead has remained at a good price during the quarter, and the exportations also show a satisfactory increase for the first eight months of the year :—

LEAD AND LEAD ORE OF ALL SORTS.

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	2746	Aug. 31, 1857	22,363
" 1856	3349	" 1856	18,152
" 1855	2546	" 1855	19,737

The importations of lead have been—

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	1147	Aug. 31. 1857	7020
" 1856	1472	" 1856	5725
" 1855	216	" 1855	4594

During 1856, and the early part of this year, tin rose to an unusually high price, which enabled mines of that metal to give results more favorable than they would otherwise have done. In 1856, at least eight tin mines paid dividends which had not done so in 1855, and others were enabled to meet their expenditure which could not have done so under the ordinary prices. About three months ago a reduction in price took place, the effect of which soon made its appearance in the accounts of several concerns, but the sales of Banca tin having gone off at increased rates caused an immediate reaction, which has since been maintained. The exportations of tin have been—

TIN, UNWROUGHT.

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	276	Aug. 31, 1857	1527
" 1856	166	" 1856	1154
" 1855	162	" 1855	989

TIN-PLATES.

Month ending—	Declared value.	Eight months ending—	Declared value.
Aug. 31, 1857	£160,476	Aug. 31, 1857	£1,108.036
" 1856	114,125	" 1856	921,671
" 1855	108,018	" 1855	742,970

The importations have been—

TIN IN BLOCKS, &C.

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	18[illegible]	Aug. 31, 1857	1237
" 1856	72	" 1856	15[illegible]4
" 1855	87	" 1855	1071

The exportations of Foreign and Colonial Tin have been—

Month ending—	Tons.	Eight months ending—	Tons.
Aug. 31, 1857	47	Aug. 31, 1857	273
" 1856	3	" 1856	81
" 1855	43	" 1855	207

In the past quarter the sum of 108,690*l.* has been divided, and 360,837*l.* in the first nine months of the year. The latter may be thus analyzed :—

English mines	£309,557	0	0
Irish mines	29,125	0	0
Welsh mines	11,195	0	0
Isle of Man	10,960	0	0
Total	£360,887	0	0
Copper	£249,024	0	0
Lead	49,482	0	0
Copper and Tin	34,404	0	0
Tin	27,927	0	0
	£360,837	0	0

For some years past, it has been remarked that more business has been done in mine shares in the last quarter of the year than in any other; and there are signs of this being the case in the present year, at the end of which the writer hopes and expects to show results even more satisfactory than those of 1856.

Art. IV.—MINERAL WEALTH OF GREAT BRITAIN.

Availing ourselves of the valuable statistical information prepared by Mr. Robert Hunt for the Museum of Practical Geology, we append a concise general view of the present condition, and of the progress during the past three years, of that great source of national wealth—the produce of mines.

Tin.—In 1854, the mines of Devon and Cornwall produced of tin ore, commonly called black tin, 8747 tons; in 1855, 8947 tons; and in 1856, 9350 tons. Thus we find an increased production of 603 tons in 1856 over that of 1854:—

In 1854,	at the average price per ton of	64*l.*,	the ore produced 559,808*l.*
In 1855,	" "	68*l.*,	" 608,396*l.*
In 1856,	" "	71*l.*,	" 663,850*l.*

The mean average prices of Metallic Tin have within the same periods varied as follows:—In 1854, 115*l.* 10s.; in 1855, 120*l.*; in 1856, 134*l.* 13s. From the high price of this metal there has naturally been considerable activity in the tin mining districts. Many mines which are, under those circumstances, now worked at a profit, would be unable to meet their heavy expenses should any considerable reduction take place: but the demand for this useful metal is too great at present to render this probable.

Our importations of Tin have also greatly increased.

In 1854, of tin blocks, ingots, &c. we imported	2251	tons.
In 1855, " "	1612	"
In 1856, " "	3464	"
And of regulus	749	"

Copper.—The quantities of metallic copper produced from the mines of the United Kingdom in the last three years were as follows:—

	1854.	1855.	1856.
Cornwall and Devonshire..........Tons	11,979	12,578	13,533
Sold at Swansea	1,245	1,276	1,245
Purchased by private contract..........	6,493	7,440	 9,479
Total.......................	19,717	...21,204......	24,257

The fine copper, in 1856, being the produce of 278,792 tons of copper, ore obtained from the mines of Great Britain and Ireland, the money value of the ore being 1,744,516*l.*

This exhibits, in 1856, an increase in our production of copper of 2963 tons over that produced in 1855, and of 4540 more than the quantity yielded in 1854. In the same periods, the proportion of copper produced at Swansea, from the foreign and colonial ores sold at the public ticketings at that port, have been respectively —1854, 3455 tons; 1855, 4650 tons; 1856, 4837 tons. The money value of the copper produced at our British smelting works being, in 1854, 2,331, 804*l.*;1855, 2,867, 207*l.*; 1856, 2,846, 803*l.* The mean average market price of the several varieties of metallic copper being, in 1855, 130*l.* 5s.; and in 1856, 125*l.*

Lead and Silver.—More than 400 lead mines sold lead ore during the year. The produce of the mines of the United Kingdom in 1856, and the two preceding years, was as follows:—1854, metallic lead, 64,005 tons; in 1855, metallic lead, 73,091 tons; 1856, 73,129 tons. It will be seen that there has been a very uniform rate of producton of lead from the British mines, but at the same time our importations of this metal have been larger than they were in 1855, when we imported 7246 tons of lead, the quantity received in 1856 being 10,254 tons. This is still less, however, than the imports of 1853 and 1854, which were respectively 17,564 tons and 11,858 tons. The mean average prices per ton of lead ore, as deduced from the public sales, were—in 1855, 14*l.* 4s. 6d.; in 1856, 14*l.* 8s.; the money value of the lead ore sold in 1855 being 1,311,971*l.*, that of 1856, or 101,997 tons, being 1,431,5091. The mean average price of pig lead in 1855 was 23*l.* 3s. per ton, and 1856 it was 24*l.* per ton. The actual market value of the lead smelted being, in 1855, 1,692,055*l.*; and in 1856, 1,755,096*l.*, to which must be added the silver extracted, the quantities being in the last three years as follows:—

1854 ....Ozs.	562,659	......Value, £140,666
1855	561,906	 140,476
1856	614,188	 153,547

In 1855 we imported 722 tons of silver ore, producing 2,112, 246 ozs. of silver; and in 1856, 6636 tons, which gave 1,748,735 ozs. of that metal.

Zinc.—From the small demand for English zinc ores, com-

paratively limited quantities were raised for many years. The sulphides of zinc have become more valuable, and hence they have been raised and sold in larger quantities than they have been for many previous years, 9003 tons being sold in 1856, producing 27,445*l.* The importations of zinc have declined. Of spelter, we received in 1853, 23,419 tons; in 1854, 19,583 tons; in 1855, 17,845 tons; and in 1856, 18,213 tons. During last year we exported 3153 tons of British zinc, while in 1855 we only sent out of the country 2516 tons.

Iron.—The enormous increase which has taken place in our iron manufacture will be seen upon reference to these returns. The returns of iron ore are far more complete than those which have been given in any former publication, and they may be regarded as a very close approximation to the real produce of all the iron producing districts of the United Kingdom. Those returns show that 10,483,309 tons of iron ore have been raised, and that 3,586,377 tons of pig iron have been produced. Iron ores have sold, according to their respective qualities, at the mines for prices varying from 5s. to 15s. per ton. The mean average price of iron ore computed from the sales of all the districts, has been 11s. per ton. This will give 5,695,815*l.* as the value of the iron ore produced in 1856 in Great Britain. The total produce of pig iron, at the mean average market price, will give a money value equal to 14,545,508*l.*

Coals.—The large development of our iron and other manufactures has naturally led to a considerable increase in the quantity of coals raised. Notwithstanding the great excess of this return in 1854 over any previous computation, I find it greatly exceeding in 1856 even that surprising quantity, the coal produce of the last year amounting to 66,640,450, which at the average price of coals at the pit's mouth, gives a money value equal to 16,663,-862*l.* There has been an increase of nearly 1,000,000 tons in our exports to foreign countries, and the quantity of coals sent coast-wise is larger than in any former year.

Among the smaller articles of mineral produce, salt, iron pyrites, arsenic, barytes, and fluor-spar, show a much higher value than those substances were generally thought to possess.

Although the returns of building stones have been considerably increased, yet the detailed lists are very far from being perfect. Enough, however, has been done to enable, by careful computation, a tolerably close estimate of the value of these important productions to be made. The difficulty of obtaining returns of the quantities of clay manufactured are so great, that, with the exception of the finer varieties, it appears at present almost impossible to arrive at any approximation of the value of this natural production.

The value of the mineral productions of the United Kingdom has been estimated in the following table, upon the principle of

taking the mean average price of all the substances at the mine, colliery, or quarry, before any charges for carriage have been made, or cost for manufacture:—

Value of the Mineral Produce of the United Kingdom, 1856.

Tin Ore	£663,850
Copper Ore	2,343,960
Lead Ore (as sold containing silver)	1,431,509
Zinc Ores	27,455
Iron Pyrites	46,066
Arsenic	1,911
Nickel and Uranium	527
Iron Ore	5,695,815
Coals	16,663,862
Salt	558,998
Other Minerals	10,000
Porcelain and Fire Clay	120.896
Total	£27,559,844
Building Stones, estimated on basis of returns and prices given	3,042,478
Total	£30,602,322

The market value of the manufactured metals has amounted to the following sums:—

Tin	£808.241
Copper	2,846,803
Lead	1,755,096
Silver	153,547
Zinc	225.075
Pig-Iron	14,545.508
Other Metals	100,000
Total	£20,434,270
Other Mineral Products, exclusive of building stones	17,348,751
Total	£37,783,021

ART. V.—ON THE GEOLOGY AND PHYSICAL GEOGRAPHY OF NORTH AMERICA. By Prof. HENRY D. ROGERS, from the United States.

(Continued from page 51, vol. ix.)

THE GREAT WESTERN DESERT PLATEAU.

BETWEEN the Rocky Mountains on the east, and the Pacific Alps, Cascade Chain, and Sierra Nevada on the west, there stretches from the Gulf of California to the Arctic Ocean, an ele-

* Notices of the Meetings of the Royal Institution of Great Britain, Feb. 8th, 1856.

vated desert zone of great breadth and height, especially in its central section, between latitudes 35° and 45°, where its mean level above the sea is about 5000 feet. It consists of three principal regions,—the Central Desert Plateau, now indicated; a semi-desert area, south-east and south of this, the basin of the Rio Colorado, divided from it by the Wahsatch Mountains; and a northern region, that of the Columbia and Frazer's rivers, sterile and rugged, separated from the central by the mountains south of the Columbia.

The Central Plateau, or Great Utah Desert, is an almost rainless region, parched by dry winds. The evaporation balancing the rain-fall, none of its scanty drainage passes to the sea, but each attenuated stream ends in a closed lake, the water of which is more or less salt. It is a vast elevated arid waste, containing wide plains encrusted with salt, a soil generally more or less saline, and large tracts of light volcanic scoriæ and ashes. Through its centre there runs, southward, a broad belt of straight mountain ridges, the Humboldt Mountains, composed in part of crystalline rocks, in part of carboniferous limestone, and other palæozoic strata. The chief stream is the Humboldt River, which, flowing west, dies away in the salt plain before it reaches the foot of the Sierra Nevada. There are twelve or fifteen salt lakes of considerable magnitude in this high insulated basin. The largest of these is the Great Mormon, or Utah Salt Lake, the waters of which are impregnated almost to saturation, containing 20 per cent. of common salt, and 2 per cent. only of other salts. Its length is seventy-five miles, and mean breadth about thirty miles.

The Southern Desert Basin, or that of the Rio Colorado, lying between the Rocky Mountains and the Wahsatch and Californian Mountains, is, like the Utah Desert, a succession of arid table lands and plains, intersected by rugged mountains. Its northeastern portion is better fed with rain than its western; those tracts most under the lee of the intercepting barrier of the Pacific Mountains being more desiccated than the districts further removed. The Pacific mountains are also less elevated in this latitude than further north, opposite the Central Desert. This Southern or Colorado Desert slopes gently southward to the ocean level at the head of the Gulf of California, north of which there is an arid tract of the surface, which is actually lower than the surface of the sea, believed to have a depression in its centre of 300 feet,—a region of continual depression, from which the dry winds have lapped up the remnant waters of the Gulf of California, and annually drink away every trace of the back waters of the Rio Colorado, at the season of its rise from the rains in the mountains. In some localities along the western edge of the Colorado Desert, the rounded water-worn pebbles which strew the surface are beautifully polished, from the action of the sharp dry sand driven furiously over the gravelly pavement by the

prevailing westerly winds; and in several of the gorges or passes through the Sierra Nevada, in the same neighborhood, the fixed rocks of the mountains are themselves smoothed and striated by the same agency.

THE PACIFIC MOUNTAIN CHAIN.

The third, or western belt, of the great elevated mountain zone of Western North America, is the oceanic chain which runs adjacent to the Pacific from Russian America to the peninsula of Lower California. The northern section of this chain traversing Russia and British America, is sometimes called the Pacific Alps; the middle section, from Frazer's River to the Klamath, the Cascade Range; and the southern section, lapping past part of the southern end of the latter, and extending from the Columbia River to about lat. 35°, and becoming extinct in the San Bernadino country, is called the Sierra Nevada. The central ridge of the Peninsula of Lower California, a part of the same great Pacific chain, is the southward prolongation of a parallel mountain axis, which in Middle and Northern California ranges parallel to the Sierra Nevada, west of it, and close to the Pacific coast, and is there known as the Coast Mountains. Low in its southern sections, this great Mountain chain in Middle California, Oregon, and Russian America is broad, complex, and very lofty, its main central crests containing nearly the highest summits upon the continent. The Sierra Nevada, a great watershed, insulating the high rainless plateau of Utah from the basin of Calfornia and from the sea, carries a very elevated crest, many parts of which reach a height of 10,000 feet; but it has few insulated peaks towering above this line. The Cascade range, on the contrary, wholly different in its geological structure, being largely volcanic, is cleft nearly to the sea level in many places, and yet bears some of the most colossal conical summits to be met with on the globe. The three great volcanic peaks, Mount Jefferson, Mount Hood, and Mount St. Helen's, tower in great masses to the height of 15,500 feet, and even above this. Mount Fairweather, 14,782 feet high, and Mount St. Elias 17,850 feet, are both volcanoes, believed to be occasionally active; while Mount St. Helen's and Mount Regnier, though rather torpid, are known to be occasionally in eruption. About latitude 35°, the Sierra Nevada and the coast range diverge northward, to enclose between them the gold-producing valley of California.

The geological constitution of the Pacific chain differs in its different sections. The Sierra Nevada, peninsular chain and coast mountains, consists largely of the azoic or semi-crystalline strata, with belts of the gneissic and true plutonic rocks, in some parts of their higher crests, and in less proportion, the older palæozoic rocks low upon their flanks. The Cascade chain, commencing in the huge extinct volcano Mount Shaste, and crossing

the Klamath, Columbia, and Frazer rivers, dividing the northern desert from the Pacific slope, is composed entirely of comparatively recent volcanic emissions, though in some tracts it contains also belts of the older crystalline rocks. This mixed volcanic and plutonic character appears to characterize this chain throughout its long course into Russian America.

THE PACIFIC OR WESTERN SLOPE.

Between the great Pacific chain and the western shore of the continent there extends the very long and comparatively narrow Pacific slope, everywhere declining more or less steeply to the sea. Slender in the California peninsula, it widens north of lat. 34° to admit the coast mountains and the gold-bearing valley of upper California, here presenting three subordinate belts, covering a breadth of about 100 miles, which dimension it maintains to Vancouver's Island, and beyond it. From the valley of the Sacramento northward, its surface becomes more rugged.

The geological constitution of the Pacific slope is considerably more diversified than that of the Atlantic slope, descending eastward from the Appalachians. It consists generally of tertiary trata, mainly of miocene age; eocene, pliocene, and pleistocene, having also been recognized. These tertiaries are generally undulated and broken from violent crust movements, and in some quarters they are extensively penetrated by eruptive volcanic rocks; in other tracts the older azoic and palæozoic rocks, and still more ancient gneissic strata, forming the spurs of the coast range, intrude themselves through the tertiaries, which have probably been deposited around these ancient masses while they were above the waters.

THE ATLANTIC OR EASTERN SLOPE.

This long and slender zone stretches from the Gulf of St. Lawrence to the Gulf of Mexico, and descends with a gentle lateral slope from the base of the Appalachians to the Atlantic coast. Its several subordinate belts differ both in physical features and geological structure. One subdivision, ranging from the Gulf of St. Lawrence to the Hudson, through New Brunswick and New England, has a hilly surface, and many rivers, which meet the tidal level far inland from the sea. It contains short chains of rounded hills, some of them mountains in size, and it is spotted with a multitude of clear lakes and ponds, and it is throughout admirably watered. This region forms one general slope to the sea, not being fringed on its ocean border, as the corresponding zone further south is, by a true tide-water tertiary plain.

In its geological composition, this north-eastern division of the Atlantic slope consists generally of the older crystalline rocks, with palæozoic strata resting upon them. Its entire surface is

covered with northern pleistocene drift, to so great a depth in some tracts as effectually to conceal the formations underneath. The limpidness of its streams and lakes must be attributed mainly to the filtering action of this sandy and gravelly bolder drift, which contains but little dispersed clay, though beds of pure brick clay regularly stratified do occasionally occur in it.

The south-western section of the Atlantic slope, expanding south-westward from the Hudson, attains in Virginia a width of at least 200 miles, under which it continues to the southern end of the Appalachians. It includes two parallel belts, quite distinct in their geology and scenery; that nearest the mountains is a true slope, descending from a height of several hundred feet to the level of the tide; that bordering the sea is a low monotonous and very level plain. Between the slope and the plain runs a well defined line of demarcation, indicated in a sudden change in the topography, and in the abrupt transition in all the streams, from rapids to the ebb and flow of the tide. Upon this physical boundary are seated all the chief cities of the Atlantic seaboard, from Trenton, in New Jersey, to Halifax, in North Carolina. This line marks, indeed, an ancient sea-coast of the earlier continent in the times anterior to the elevation of the horizontal tertiary deposits.

The upper, or Appalachian division of the Atlantic slope, traced south-westward, ascends from the level of the tide at the Hudson, to its maximum height of 1000 feet near the sources of the Roanoke, and declines again beyond the Catawba, to a more moderate level in middle Alabama. From Long Island Sound to the Potomac its surface is varied and pleasing, and its soil very fertile.

Geologically, this belt includes tracts of the gneissic series, and synclinal troughs of the most ancient palæozoic formations—all in a more or less metamorphic condition. These are overlaid by a zone of middle secondary red sandstone, of older Jurassic age. This zone embraces low, rugged wooden ridges, and hills of trapean and other gneous rocks. It possesses many broad, fruitful, and salubrious valleys; is singularly well-watered by clear running brooks, but is nowhere marshy, and is altogether the garden spot of the Atlantic border of the continent.

From the Potomac, south-westward, the features of this slope are more monotonous, the soil less fertile, consisting of light sands and meagre clays, produced from the subjacent talcose and chloritic schists, and other altered azoic rocks. The climate is less temperate, being liable to great heat in summer, and to heavy rains, which wash its pulverulent soil. These conditions of soil and climate impart excessive turbidness to its swiftly flowing streams, causing indirectly extensive sand-bars and shoals at the mouths of its rivers and estuaries, tending to block the navigation. Immediately at the base of the blue ridge, in Virginia and

North Carolina, this region contains highly fertile[1] and picturesque tracts.

The Atlantic Plain, or seaboard belt of the Atlantic slope, nowhere rises above 100 feet from the ocean level. From Long Island to North Carolina, though intersected by many tidal creeks, it is not marshy, except near the ocean, and bordering the estuaries of the Delaware and Chesapeake; but farther to the south-west, through North and South Carolina, Georgia, and Florida, its seaward half is excessively swampy and much overflowed.

Geologically, this ocean border is composed exclusively of cretaceous and tertiary deposits: the former consisting of clays and sands, including thick wide-spread beds of pulverulent green sand, greatly valued as a fertilizer for the soil; the latter or tertiary of sands, clays, and beds of shell marl, with few or no concreted rocky layers. The cretaceous strata outcrop along the continental side of this plain in a narrow zone, extending from the northern sea coast of New Jersey to the Chesapeake, and reappear again low upon some of the rivers of the Carolinas and Georgia; but, throughout a large part of the plain, they are deeply covered by the tertiaries. The eocene tertiary strata have a narrow long line of outcrop in a corresponding position along the western edge of the plain, from the Potomac to the Cape Fear River; they reappear again from under the middle tertiary beds, in a more central position in the plain, from the Cape Fear River to the Altamaha. Still farther to the south-west, these eocene beds fringe the southern edge of the cretaceous regions of Georgia, Alabama, and Mississippi, south of the termination of the Appalachian Mountains. This wide southern tract of eocene extends southwards into the interior of the peninsula of Florida, showing this peninsula to have originated as early at least as the morning period of the tertiary day.

The miocene tertiaries cover nearly the whole of the tidewater plain, except the narrow eocene strip on the west, and a pliocene area on the sea coast of Virginia and North Carolina, from southern New Jersey, through Delaware, Maryland, Virginia, and North Carolina.

The pliocene deposits skirt at intervals the entire Atlantic sea coast from the Chesapeake to Florida, and also the whole coast of the Gulf of Mexico, from Florida to Texas; forming, for the most part, a fringe to the eocene beds, the miocene not having been deposited in these regions.

GEOLOGICAL FEATURES OF THE UNITED STATES.

Turning next to a more special description of the geological features of the United States, the speaker sketched briefly the great natural areas occupied by its separate formations.

1st. To the north of the east and west Lawrentine watershed, which itself consists generally of the ancient crystalline rocks, including the older metamorphic or gneissic, later metamorphic or azoic, or non-fossiliferous palæozoic strata, and many plutonic outbursts; there extends to a high latitude, and filling a part of the natural hydrographic basin of Hudson Bay, an area or basin of fossiliferous palæozoic strata of the upper Silurian, Devonian, and possibly Carboniferous periods. This may be called the Hudson Bay, or Arctic Palæozoic Basin.

To the south of the before-mentioned Lawrentine igneous watershed, and westward from the Atlantic slope to the Rocky Mountains, and even to the great Pacific chain, and probably north-westward to the basin of Mackenzie River, there spreads another still larger palæozoic basin. The south-eastern and best developed part of this area, from the Appalachians to the plains of Kanzas and Nebraska, entitled the Appalachian Basin, includes formations of all the palæozoic periods known to geologists, from the dawn of life upon the globe, to the close of the age of the coal.

From this brief statement of the two basins, and an inspection of the geological map, it appears that the Appalachian Basin, or that south of the Lawrentian Lakes, was depressed or under water in the earlier palæozoic periods, while the region north of the Lawrentine watershed was above the level of the sea. But at the close of the Cambrian or older Silurian ages, that great disturbance of the crust, which let the ocean in upon the area of the present basin of Hudson Bay, for the production of the Silurian and later strata, lifted out a part, and shallowed other portions of the sea-bed of the other, or Appalachian Basin, to the south. This is manifested in a break in the sequence of the strata, wherever the older Silurian or Cambrian, and the later palæozoic rocks are there recognizable together.

The first stage, then, in the physical geography of the primeval North America, was the existence of a small northern continent, the southern coast of which was nearly coincident with the northern skirt of the present valley of the St. Lawrence and its lakes. This continent or nucleus of one, sent forward to the south a long peninsular tract, the vestiges of which we may discern in the hypozoic and azoic belt of the Atlantic slope, stretching from New Brunswick to Georgia. Very possibly other lands lay to the eastward of this region of the Atlantic slope at that early date, and were depressed during some of the earlier oscillations of the crust in this quarter of the hemisphere; the seeming eastern origin of many of the Appalachian palæozoic strata, to the coal rocks inclusive, is eminently suggestive of the existence in the palæozoic times, of some such large tract of land, and ancient Atlantis, now under the bed of the western part of the Atlantic.

The next general movement of the crust, in the region now constituting the eastern half of North America, was at the end of the coal period, manifestly an epoch of very extensive uplift of the continent. This shift of level, and total drainage of the eastern half of the Appalachian sea-bed, caused a large accession to the continent, the new shore of which, if assumed to be coincident with the line which now separates the palæozoic Appalachian formations, and yet older ones of the Atlantic slope, from the later horizontal cretaceous and tertiary deposits that fringe them, was that well-marked physical limit already partially traced as the inner edge of the low tertiary and cretaceous plain. Probably, however, this newly-produced part of the continent, particularly on its western side, was somewhat more extended at the date of elevation than the present margin of the cretaceous formation indicates; for it is upon this supposition, coupled with a belief that the newly uplifted formations remained out of water, under somewhat wider boundaries than they now exhibit, that we can best explain the non-existence of any Permian and Triassic formations between the Carboniferous, the latest of the Amercan palæozoics, and the Cretaceous, the next more recent sediments deposited against them. During all the long geological ages which intervened between the lifting out the palæozoic region of the United States east of the Missouri, and the deposition of the Cretaceous strata, no sedimentary formations of the Mesozoic periods, such as those which fill large tracts in other quarters of the globe, were permanently upraised into dry land, saving only a few narrow strips—products of estuary sedimentation—stretching at intervals along the Atlantic slope from Prince Edward's Island to Carolina. Elsewhere, certainly as far westward as the Rocky Mountains, either nothing was deposited during the permian, triassic, and jurassic ages, or what is far more probable, the formations then produced were formed outside of the present palæozoic limits, and have been covered up from sight by the wider sediments of the cretaceous sea, which, lapping over them, have shut in all the earliest border tracts of the palæozoic lands, formed at the end of the coal period.

The nature of the crust movements which elevated the palæozoic strata was in the region of maximum disturbance—that of the Atlantic slope and Appalachian chain,—a stupendous undulation or wave-like pulsation, the strata being elevated into permanent anticlinal and synclinal flexures remarkable for their wave-like parallelism, and for their steady declining gradation of curvature, when they are compared in any east and west section across the corrugated zone. To the westward of the Appalachian chain, where this structure is so conspicuous, the crust waves flatten out, recede from each other, and vanish into general horizontality; and this nearly level condition extends thence throughout all the older rocks to the plains of Texas and Nebraska,

where the cretaceous beds overlap them. The orogaphic features of the Appalachian chain, even to the minutest slopes and terraces upon the flanks of the ridges, are all beautifully impressive of the carving action of deep retreating waters.

The cretaceous deposits of the United States all imply a marine origin, no fresh water remains having hitherto been discovered among them; and the geological map now exhibited pictures approximately the wide extent of the cretaceous, or later mesozoic sea, as it washed the boundaries of the palæozoic continent. The shore of that sea was, as before hinted, the inner edge of the Atlantic plain on the east; on the south it was the southern termination of the Appalachian chain and the other great north-east and south-west palæozoic tract, west of the present Mississippi; and on the west, for a long distance northward, it coincided generally with the present valley of the Upper Missouri. This cretaceous sea lapped round the southern end of the Rocky Mountains, and spread as far to the west as the Cordilleras of New Mexico and the Wahsatch chain of Utah. We do not at present know that it extended any further.

The close of the cretaceous or chalk period was marked by the rise and desiccation of nearly the whole now continental area of this great northern Mediterranean. The movement along the Atlantic border of the continent was comparatively slight, for it brought above the sea level only very limited and narrow tracts of the shoal water cretaceous sediments. South of the Appalachian region it was somewhat more extensive, elevating a wider zone between the previous dry land and the newly-formed tertiary shore; but to the west of the region of older rocks it was a broad continental rising, draining dry nearly the whole bed of the then existing ocean to the limit indicated beyond the Rocky Mountains. The coast line established by this lift of the crust, set new and much more restricted bounds westward and northward to the Atlantic Ocean, and established the outlines of the present Gulf of Mexico, which thus dates back as far as the commencement of the eocene tertiary age. It does not seem probable that Florida was then any part of the dry land, the true southern peninsula of the continent being rather the newly-formed cretaceous plain at the end of the Appalachians.

From that date, the movements in the level of the continent have been manifestly less and less. Its great outlines, established at the close of the chalk period, have remained as its contour to the present day; and each successive gain of territory, during the several tertiary revolutions—that which ended the eocene, that which closed the miocene, and that which cut off the pliocene, and even the pleistocene deposits, was but an enlargement of the primitive mesozoic pattern, a mere addition of a lighter and lighter fringe to the broad mantle of land, which earlier convulsions had constructed.

(To be continued.)

ART. VI.—EXPERIMENTS ON THE TEMPERATURE OF THE EARTH AT GREAT DEPTHS. Translated from the French by GEORGE W. ALEXANDER, of the U. S. Navy.

THE variations of temperature, which result from the influence of the seasons, are felt at but a very small depth in the interior of the earth; the temperature from the soil is at a little depth variable according to the situation of the places, and equal to the mean temperature of the locality. But below this mean temperature the heat increases in a ratio as we descend, and the result of the observations made up to this time gives an increase of one degree for each 107 feet of depth. The result of which is, that about three kilometres below the point of mean temperature we should find already 100° (centigrade), or that of boiling water; and should the law continue regularly, we should have, at twenty kilometres, 666 degrees, a temperature at which many silicia would be in a state of fusion.

Towards the centre of the earth, that is to say, at a depth of 6366 kilometres, we would have a temperature of 200,000 degrees, a heat of which we can form no idea, and which would not only be capable of melting, but volatilizing all bodies. It is, however, hardly probable that the heat increases always uniformly; it is to be believed that there is soon established a *general equilibrium*, and that at a depth of 150 or 200 kilometres, there is a uniform temperature of 3,000 or 4,000 degrees, the greatest heat that we can produce, and which nothing can resist. Thus it is highly probable that the interior of the earth is fluid, and that only upon the surface is there a crust of 20 kilometres in thickness.

However, the experiments already made upon the central heat of the earth, leaves yet much to desire, and the works of boring executed at Creuzat, by the process of M. Kind, when examining for coal last year, reached the depth of 600 metres. The opportunity thus offered for experimental examinations in regard to this law of increase of temperature in the interior of the earth, was so favorable that M. Walferdin took advantage of it, and made some very interesting experiments with his thermometrical instruments, at depths never before attained. He says:

"Many soundings had been made at Creuzat; two of these borings, above all others, attracted my attention; in the first, that of Monillelouge, in course of execution they had attained the depth of 816 metres; in the second, that of Torcy, the work, after having reached the depth of 595 metres, had been suspended for six months.

They are both in the same direction, traversing analogous strata of the earth, and are only separated from each other by about 1,500 metres, and also being nearly the same height above the level of the sea, the difference being about 15 metres.

It was on the 13th of May, at seven o'clock in the evening,

after all work had been discontinued for 80 hours about the pit, that the thermometrical instruments were introduced to a depth of 816 metres. They were taken out on the 14th of May, at 10.55 A. M., and the vase containing them was found completely filled with compact mud, and in which they had rested during 16 hours. They indicated a mean temperature of 38° 5′. One of the glass tubes containing the instruments burst under the enormous pressure of 81 atmospheres.

Whilst the intelligent experimenter proceeded to make the comparisons from the different thermometers, M. Bauer, engineer, again introduced the instruments on the same day, 4.30 P. M. They arrived at the bottom at 5.57, and were taken out on the following day, the 15th of May, at 10.30. They had consequently been under observation for 16 hours and 32 minutes, and this second experiment was commenced 102 hours after the cessation of all work about the boring. When brought to the surface, the instruments indicated 38° 31′. It is this last result that M. Walferdin has adopted.

Torcy is situated in 1° 52′ of East longitude, and 46° 40′ 38″ of North latitude, and is 310 metres above the level of the sea. The boring, which has been carried to the depth of some 400 to 500 metres, has penetrated into the slate and sandstone of the coal strata just to the depth of 595 metres. Here all work had been suspended for a long time, and consequently they entertained no fear of an increase of temperature from percussion.

Some caving in of the earth had filled the lower portion of the pit, and it was at the depth of 554 metres only that the instruments could be put in observation. They were sunk 13 metres in the mire at the bottom of the pit, and remained during 17 hours and 38 minutes. Brought to the surface they indicated a mean of 27° 23′.

Although this last experiment left little doubt on the mind of Mr. Walferdin, yet he tried the experiment 10 days afterwards, the 22d day of May.—Placed exactly under the same circumstances as for the previous experiments, the thermometrical instruments were introduced into the *miry vase* at the bottom of the pit, and remained 17 hours and 25 minutes, and they indicated a mean of 27° 22′.

It is evident Torcy, being situated at 310 metres above the level of the sea, furnishes, at the depth of 554 metres, an excellent horizon "*thermo geoguasqtine*" for calculating the increase of temperature from the depth obtained by comparison to the 816 metres attained at Mouillelouge.

Thus the 38° 31 observed at Mouillelouge at 816 metres compares very nicely with the 27° 22 indicated at Torcy at the depth of 554 metres, giving for a difference of 262 metres an augmentation of temperature of 11° 09, one degree for 23.6 metres.

We can start equally from this horizon of 554 metres to cal-

culate with the same certainty the increase of the temperature or terrestrial heat just to the surface of the earth.

The favorable position of Torcy—its longitude, its latitude, and its altitude—gives us the approximate valuation to 9° 2, which gives an increase of temperature of 18° 02 for 554 metres, or one degree for 30.7 metres.

Thus the observations of Torcy and Mouillelouge show that at Creuzat the terrestrial heat increases from the surface of the earth to a depth of 550 metres of 1 degree for 30 to 31 metres; but that at 550 to 800 metres this increase is more rapid, since one degree corresponds but to 23.6 metres. In face of this result the intelligent experimenter doubts if, in spite of the precautions that were taken at Mouillelouge to try the beds at their normal temperature, the effect that produced the percussion was entirely annihilated.

The boring at Mouillelouge has at present reached the depth of 900 metres, and it is probable that ere long 1,000 metres will be reached; and M. Walferdin hopes to renew these experiments that are invested with so much interest.

For the benefit of such of your readers as are not acquainted with the thermometer of Celcius and the French measures, I subjoin the following. Any number of degrees marked Centigrade can be reduced to Fahrenheit by the following:

Fahr.=9 + 5 Celci. + 32.

Example–100° Centi.

$$\begin{array}{r} 9 \\ \hline 5)900 \\ \hline 180 \\ 32 \\ \hline 212° \text{ Fah.} \end{array}$$

A French metre equals 39.38 inches.
A kilometre do 1,000 metres.

Art VII.—ON THE DECLINE IN THE VALUE OF THE PRECIOUS METALS.

Under this title the *Reveux des deux Mondes* has published three interesting articles by M. Michel Chevalier. Starting from the admitted fact, that the manner in which a decline in the value of the precious metals is rendered perceptible to the public, consists in an increase in the price of provisions and merchandise he opines that we are about to witness a rise in the value of every necessary and luxury of life, similar to that which occurred at the time of the discovery of America by Christopher Columbus. That such a rise has already commenced, he thinks cannot be

denied, though he admits that other causes—such as war, and an increase of consumption—have contributed to produce it. He then proceeds to compare the quantity of gold produced at the beginning of the present century (about 24,000 kilogrammes per annum), with the present amount obtained from California, Australia, and Siberia (300,000 Kilogrammes per annum), being in a single year about a tenth part of all the gold furnished by America during the last three centuries. Here he introduces a new view of the subject. While the gold-seeker of the Rhine (for there are still some, and whose joint efforts do not produce more than 15 kilogrammes of gold per annum) is content with about two francs a day as the reward for his labor, the Californian and Australian diggers consider 19 francs the minimum remuneration they may expect. Now, supposing the yield of the gold fields to remain unvaried, the value of gold may decline until 19 francs become the ordinary salary not only of a digger, but of any laborer whatever in California and Australia, the cost of provisions and the rate of remuneration being supposed to have then attained that natural level which is still wanting in those countries. But this level once attained, it may be reasonably presumed that the market-price of labor in the auriferous countries must have arrived at about the same standard as in the most civilized countries of the Old World, viz.: five francs a day. Therefore, in the above hypothesis, the value of gold may fall until the price of 5 1-2 grammes, which is now 19 francs, comes to be only five francs.

M. M. Chevalier shows that France is the country where the largest quantity of gold has been coined during the last seven years; seeing that, although England has, within that period, reached the enormous sum of £45,749,868 (1,153,000,000 francs,) still France is ahead of her by 1,024,000,000 francs. On the other hand, the coinage of silver has diminished, and silver coin itself has almost disappeared from circulation. The author now examines the question as to whether the present annual yield of gold is likely to be permanent; and he comes to the conclusion that it is very probable it will last long enough to occasion a fall in the value of the metal.

But it has been argued that the surplus of gold now thrown into circulation will be absorbed: 1. by those countries (such as Turkey, the United States and Austria) where every kind of metallic currency is extremely scarce; 2. by the increasing habits of luxury which distinguish our period; 3. by the increase of population, and consequent increase of business in Europe.

As regards the first, M. Chevalier remarks that although the United States have decided upon coining a large quantity of gold pieces, the country possesses such a vast circulation of paper currency, comprising notes of as low a value as $5, and even $1, and the habit of keeping a running account with banks is so

general, that a coinage of 500,000,000 of francs' worth of gold is likely to meet every emergency. Austria may, perhaps, absorb a similar amount, but not more, since she also possesses a large paper currency, and moreover, owing to the new federal monetary system to which she has subscribed, rather inclined to increase her silver than her gold currency. The wants of Turkey cannot be estimated; it is a country without either commerce or credit, and may be left out of the account. Moreover, if the countries best disposed to absorb gold are to be taken into account, why not, M. Chevalier asks, also mention those, such as Holland and Belgium, for example, that are inclined to repudiate gold altogether as a circulating medium? Again, in Asia and Africa the currency preferred is silver. Hence M. Chevalier thinks that in the course of the next ten years 300,000 lbs. of gold is the utmost that can be coined by the countries above mentioned.

As for the quantity of gold likely to be absorbed in the manufacture of articles of luxury, M. Chevalier is not inclined to attribute much importance to it. In the first place he observes that, in our days, luxury does not consist so much in a great display of gold as in the use of rich silks, the purchase of works of art, and such like. Some gold is used in gilding apartments and furniture, but gold trinkets are made very light, and the quantity of metal used for watch-cases and rings is extremely limited. It would be but natural to suppose that, owing to the immense commercial prosperity of England, the manufacture of gold articles must have experienced a large increase; and yet, from the official returns of the assay offices, it appears that the manufacture in question has by no means kept pace with the increase of population; for the present amount of the former is only 50 per cent. more than what it was at the commencement of the century, while the population has exactly doubled within the same period. Moreover, the annual quantity of gold the trade consumes is but an atom compared with the quantity extracted, being, on average, not more than 7,636 ounces, articles for exportation included. The author arrives at similar results as regards France, and at length reminding his readers that in 1827 M. de Humboldt fixed the quantity of gold annually manufactured in Europe (old metal included) at 9,200 kilogrammes he consents to double that sum and to make no allowance for old metal, so as to admit that 18,400 kilogrammes of new metal are annually thrown into the jewelry trade in Europe, or perhaps 25,000 kilogrammes if America be taken into account. Continuing his calculations, he allows about 10,000 kilogrammes per annum for gilding and gold lace.

Lastly, as regards the immense development of trade, which is believed to require a considerable increase of metallic currency, M. Chevalier is of opinion that no allowance ought to be made for this item, seeing that most commercial affairs are settled by a irculation of paper, and that payments in specie only occur for

small balances. An increase of population does indeed call for an increase in the metallic currency, but by no means in the proportion of the actual production of gold. One of the natural effects of circulation is a loss in the quantity of metal by friction or *wear;* this M. Chevalier lays down at ten millions of francs per annum; and he allows an additional fifty millions of francs for casualties and shipwrecks. From all these calculations, and making the largest allowances, it appears that in the course of the next ten years a total of about 1,050,000 kilogrammes of gold may be thrown into the market without overstocking it. But during the same period, and at the present yield, 2,500,000 kilogrammes will have been produced; there consequently remain 1,450,000 kilogrammes of gold to be disposed of. These will assuredly be absorbed, because the current of circulation is insatiable; but on one condition only, *that of a proportionate fall in the value of the precious metal.*

Having arrived at this conclusion, M. Michel Chevalier lays it down as a well-known axiom, that in all those countries where gold is a legal tender, a decline in its value is necessarily followed by a general rise in prices, and he then proceeds to examine which of the two precious metals is a legal tender in France. After an elaborate sketch of the history of the French currency from the remotest times, he arrives at the final conclusion that the real standard of value in France is the silver franc, and that gold, although at present thrown into the circulation to an immense amount, has never been recognized as a legal tender.

The author of the article now arrives at the most important point of the question: What will be the effect of a fall in the value of gold, and how can the dangers resulting from it be avoided in France? Here he traces an animated picture of the consequences which would attend a diminution in the price of gold in those countries where it is a standard value; how the creditor will lose and the debtor be a gainer; how the working classes will have to struggle with unforeseen difficulties, because employers will resist a demand for increase of salary until the last moment, and how governments will be obliged to run the risk of insurrections by increasing the national charges. But will governments in such a case be either legally or morally bound to afford compensation to the public? M. Chevalier thinks that England will not, because her standard of value is gold; she has engaged to pay the public creditor in so much gold; she has fulfilled that engagement at a time when gold was scarce, and she, therefore, has a right to do the same when it is over-abundant. But France, whose legal standard is silver, is clearly bound in conscience to make good the loss the holder of gold will incur, in consequence of the immense quantity of that metal put into circulation together with silver. We omit some other collateral questions here touched upon by the author, to come at once to

the remedies or precautions to be taken against the impending fall. First, the government might have recourse to repeated recoinage of gold pieces, each time increasing the quantity of metal, a plan which would only breed confusion. Next, it might recoin its gold, once for all, in pieces on which the weight, instead of the number of francs, might be marked. Under this system, the most rational one, according to the author, a gold piece of 5 grammes, for example, would have a variable value, determined by periodical tariffs published by Government, according to the price of the metal in the chief markets of Europe. A third mode would consist in at once decreeing that the gold pieces now in circulation shall have a variable value, according to the state of the market; so that a 20 franc piece may, for example, only cost 19fr. 50c., &c. Here M. Chevalier enters at large into the questions the latter measure would involve, and quotes the precedents of Russia, Holland and Belgium, in support of several of his views; and concludes with examining the opinion of other writers on this question of the day, who propose to make gold the legal standard, instead of silver. Should that opinion prevail, M. Chevalier gives it as his conviction that, in a few years, France would lose all her silver, to the last five-franc piece.

ART. VII.—OBSERVATIONS UPON THE CARBONIFEROUS LIMESTONES OF THE MISSISSIPPI VALLEY.* By JAMES HALL.

THE object of this communication was to show that certain reliable and well-marked subdivisions exist in the "*Carboniferous limestone*," as it is usually termed, of the Mississippi valley. The subdivisions heretofore proposed were founded, in part, upon certain supposed characteristic fossils, such as the Archimedes, the Pentremites, etc., which, though reliable as individual species in their geological range, are not, as genera, characteristic of the subdivisions. The subdivisions proposed in the report of Dr. D. D. Owen are, first, an upper and lower series, each of which is again subdivided into several distinct beds or groups. For the sake of comparison, this table of Dr. Owen's is here given:

"SECTION OF SUB-CARBONIFEROUS LIMESTONES OF IOWA.

Coal Measures.

20 feet.—Upper concretionary limestone.
10 feet.—Gritstones.

* From the Proceedings of the American Association for the Advancement of Science. The same subject essentially forms a part of the Report of Progress of the Iowa Geological Survey.

30 feet.—Lower concretionary limestones.
10 feet.—Gritstones.
10 feet.—Magnesian limestone.
30 feet.—Geodiferous beds.
50 feet.—Archimedes limestone.
15 feet.—Shell beds.
15 feet.—Keokuk cherty limestone.
70 feet.—Reddish brown encrinital group of Hannibal.
55 feet.—Encrinital group of Burlington.
75 feet.—Argillo-calcareous group, Evans' Falls."

The above expresses the measurements and succession of rocks as given in Dr. Owen's section.

Prof. Swallow, in his Report on the Geological Survey of Missouri, subdivides the Carboniferous limestones and rocks below the lower coal measures as follows:

Carboniferous limestone.	E. Lower coal measures, ...	140 feet.
	F. Ferruginous sandstone, ...	195 "
	G. St. Louis Limestone, ...	250 "
	H. Archimedes limestone, ...	200 "
	I. Encrinal limestone, ...	500 "
Chemung group.	J. Chouteau limestone, ...	70 "
	K. Vermicular sandstones and shales, .	75 "
	L. Lithographic limestone, ...	60 "

Under each of these divisions are given numerous localities where the rock is well developed.

In descending the Mississippi river, we come upon the lowest and most northerly outcrop of these limestones at Burlington, Iowa. At this locality we have the following section, in the descending order:

1. Encrinal limestone.
2. Oolitic limestone, fossiliferous.
3. Compact arenaceous limestone.
4. Fine grained argillaceous sandstone or gritstone, with casts of Spirifer, Chonetes, Productus, Bellerophon, Orthoceras, etc.
5. Green shale.

The entire thickness of 2, 3, 4, and 5, is about 70 to 80 feet: the base of the green shale however has not been observed.

These members constitute the argillo-calcareous group of Evans' Falls, in Dr. Owen's section, and the members J, K, and L, of Prof. Swallow's section. The higher beds belong to the age of the Chemung group, containing the same fossils as the rocks of that group in New York and elsewhere, and have been carefully traced throughout the intermediate space. It is quite probable that, in strict parallelism, the green shale of Burlington and Evans' Falls, which weathers to an "ash-colored earthy marlite," should be referred to the Portage group, since here it lies between well marked Hamilton beds and the Chemung. And it is likewise probable that the Lithographic limestone of

Prof. Swallow will be found more closely allied to the Hamilton than to the Chemung group.

We have however in the light colored, friable sandstones of the Chemung group, a well-marked and reliable horizon. The oolitic bed is more allied by its fossils with the Chemung below, than with the encrinital limestones above; though between the latter there is often no well-marked physical lines; so gradual and imperceptible is the change from what is termed Devonian to the acknowledged Carboniferous rocks.

The encrinital limestone of Burlington, or, as we shall hereafter term it, the *Burlington limestone*, is characterized by its great numbers of crinoids, of which Drs. D. D. Owen and B. F. Shumard have described numerous species. The rock is in a great measure composed of the broken and comminuted remains of this family of fossils: large masses of the rock consist almost entirely of the separated but unbroken joints of the columns of various species.

This rock includes the "Encrinital group of Burlington," and the "Reddish brown Encrinital group of Hannibal," in Missouri of Dr. Owen's section; the latter being in no respect different from the former, and holds precisely the same position in the series, having the same beds above and below. The "Encrinital limestone" of the Missouri report is likewise identical with the Burlington limestone, and is so recognized by Prof. Swallow.

The Burlington limestone is succeeded by cherty beds with intercalated beds of light gray limestone. These have a thickness altogether of sixty to seventy-five feet, and constitute the beds of passage to the next division of the limestones. The cherty beds form the rapids above Keokuk, so well known in the navigation of the Mississippi river. These are termed by Dr. Owen the Keokuk cherty limestones. The so-called siliceous formations of Tennessee and Alabama are of the same strata.

The second important limestone is recognized in the sections both of Prof. Swallow and Dr. D. D. Owen as the "*Archimedes limestone*," from containing a bryozoan of the genus *Fenestella*, with a spiral axis,—the *Archimedes* of Lesueur.*

On descending the Mississippi river, this limestone is found at Dallas, at Appanoose, and opposite to Madison, and at Nauvoo, Ill., and is largely developed at Keokuk; the shell beds of Dr. Owen forming a subordinate member of the mass. The *Archimedes* is extremely rare in all these localities, as well as at Quincy, Ill., where the lower part of the rock is seen resting on the cherty beds which separate it from the Burlington limestone.

This limestone which may for convenience be termed the Lower Archimedes limestone or Keokuk limestone, contains numerous characteristic fossils. In the upper part the *Archimedes*

* See observations upon the genus Archimedes or Fénestella, following this article.

occurs sparingly, with *Cyathophylla*, *Spirifer striatus*, *fish teeth*, etc. Among the crinoids are *Platycrinus Saffordii Actinocrinus Humboldtii*, *Agaricocrinus tuberosus*, and others.

The Keokuk limestone is limited above by a mass of shales or marls with impure limestones, known locally as the "*Geode bed*," from the numerous geodes, lined with quartz crystals, chalcedony, calc spar, etc., which it contains, and which have been distributed very widely throughout the United States. This mass constitutes the "Geodiferous beds" of Dr. Owen's section, but has not been recognized in the Missouri section.

Succeeding the geode bed, and recognized in the same localities near Warsaw, Ill., at Appanoose, and other places, is a bed of magnesian limestone, given in Dr. Owen's section under the same name.

To the magnesian bed, which has a thickness of some ten feet, and is doubtless only of local development, succeeds a series of beds of blue marlites, with intercalations of impure limestones, or in some places of impure limestones separated by seams of blue marlite. The upper portions become arenaceous, and sometimes contain small pebbles, forming the gritstone of Dr. Owen's section. The central and principal portion is highly fossiliferous, abounding in reticulated bryozoa; and among these the axis of a species of *Archimedes* occurs in great numbers and of extraordinary size and perfection. So abundant is it that a dozen individuals may sometimes be seen in the space of a few feet. The species is quite different from the one in the Keokuk beds, being more robust and the volutions of the spiral axis less rapidly ascending.

This *second* Archimedes limestone seems not to have been recognized in the section of Dr. Owen; and judging from localities cited, it appears to have been confounded with the *lower* Archimedes or Keokuk limestone. The position, however, of the Warsaw Archimedes limestone is above the geode bed, the *Archimedes* is a distinct species, and it is associated with several species of crinoids, fish teeth, etc., which do not occur in the lower beds.

The arenaceous bed which terminates this group, and which likewise contains *Archimedes* and joints of crinoidal columns, is succeeded by a light gray, compact limestone, which is often concretionary or brecciated in its structure. Its most conspicuous fossil in many localities is *Lithostrotion floriforme*.

This limestone is termed by Dr. Owen the "concretionary limestone," and by Prof. Swallow the "St. Louis limestone."*

* After a careful examination of the locality cited by Dr. Owen, I am unable to find a second concretionary limestone, though it is not difficult to see how such an error should have occurred in measuring the section near the mouth of the Desmoines river.

It is the same rock which forms the low cliff below Keokuk, near the mouth of the Desmoines river at St. Francisville, Mo.; the greater part of the bluffs of the river for some distance above Alton, Ill.; the limestone of St. Louis in whole or in part; the limestone of St. Genevieve; the limestone of Prairie du Rocher, Ill.; and in part, the bluffs bordering the American Bottom, below Alton, Ill.

At this point the sections both of Dr. Owen and Prof. Swallow cease, so far as limestones are designated. The Concretionry limestone of Dr. Owen is succeeded by sandstones and shales of the coal measures, which is the true order at the mouth of the Desmoines and other places, but not universally true. In the section of Prof. Swallow, the St. Louis limestone (Concretionary limestone of Owen) is shown to be succeeded by a brown or ferruginous sandstone, F, of section of Missouri report, and upon this rests the lower coal measures. This order is likewise true of some parts of Missouri and of Illinois, but it is not every where true in these States.

The ferruginous sandstone is in turn succeeded by an extensive and important limestone formation, consisting of beds of limestone of greater or less thickness alternating with thin seams of marl or shale, and in some parts heavy bedded limestone of considerable thickness, without shaly partings or with very thin ones. The group embraces likewise one or more heavy sandstone beds, and a mass of green shale or marl more than fifty feet thick.

This formation constitutes the limestones of Kaskaskia and Chester, Ill., and those below St. Genevieve in Missouri. They occur at other places on the river, and form the greater part of the limestones of southern Illinois and Indiana, and those of Kentucky. This limestone is likewise known as the Archimedes limestone and sometimes as the Pentremital limestone, from the abundance of its Pentremites. It has evidently been always confounded with the lower Archimedes or Keokuk limestone, as is shown by the citation of localities in the reports above mentioned, and in other publications upon western geology.

The species of Archimedes which it contains in great numbers is quite distinct from the other two named, and the character of its axis alone is sufficient to distinguish the rock from either of the lower ones. The stratigraphical position of this rock is most clearly defined and readily determinable. The assemblage of fossils is distinct from all those in the rocks below, and there remains no reason for confounding it with either of the other divisions.

In following down the course of the Mississippi river, the St. Louis limestone is seen to pass beneath the ferruginous sandstone F, and upon the latter rests the limestone group of Kaskaskia, and Chester in Illinois, and of St. Mary's in Missouri.

From these data we are prepared to show the true order of the successive beds among the Carboniferous limestones of the Mississippi valley; and also in Indiana, Kentucky, Tennessee and Alabama.

The following section illustrates the preceding statements regarding the order of superposition among the different members of the limestone series.

VII.	Coal measures.	
VI.	Kaskaskia limestone, or Upper Archimedes limestone,	Kaskaskia and Chester, Ill. St. Mary's, Missouri, etc.
V.	Gray, brown or ferruginous sandstone, overlying the limestones of Alton and St. Louis,	Below St. Genevieve, Mo. Between Prairie du Rocher and Kaskaskia, Ill.
IV.	"St. Louis Limestone," or "Concretionary limestone."	St. Louis; highest beds below Keokuk. Alton; St. Genevieve.
III.	"Arenaceous bed,"	Warsaw and above Alton, Ill.
	Warsaw or second Archimedes limestone,	Keokuk, Iowa.
	"Magnesian limestone,"	Spergen Hill, Bloomington, Ia.
	Beds of passage, soft shaly or marly bed with geodes of quartz, chalcedony, etc.	
II.	Keokuk limestone, or Lower Archimedes limestone,	Keokuk, Quincy, Ill., etc.
	Beds of passage, cherty beds 60 to 100 feet.—Rapids above Keokuk.	
I.	Burlington limestone,	Burlington, Iowa; Quincy, Ill.; Hannibal, etc., Missouri.
	Oolitic limestone and argillaceous sandstone of the age of the Chemung group of New York.	Burlington, Iowa. Evans' Falls. Hannibal, Mo.

The difficulties which have occurred in the way of a reconciliation of the views of Western geologists have arisen in great part from the fact that these different limestones have not an equal geographical distribution; there being no point on the Mississippi within our knowledge where a section at right angles to this valley will embrace all the beds here enumerated. The limestones likewise change their character when examined in a north and south direction, owing to causes which will be explained. The fossil forms which have mainly been relied upon for characterizing the divisions, have been to a considerable extent of generic value only; and specific differences have not always been properly recognized.

In the geographical distribution and the changes of lithological character at different points, we have yet much to learn. These groups of limestones have been successively deposited in an ocean which was gradually contracting its limits upon the north. The lowest, or Burlington limestone, has therefore a greater extension northward than either of the succeeding groups; and its gradually thinning edges stretch far towards Iowa city, near which latitude was the northern boundary of the ocean, or at least the limit of its animal life. Considerably to the

southward of this, we first find the attenuated northern edges of the Keokuk limestone, mingled with much earthy sediment, and often consisting of a few thin beds of Encrinal limestone intercalated among other beds of an argillaceous character. It is only farther south, in the neighborhood of Nauvoo and Keokuk, that this limestone first exhibits decidedly its characteristic features The limits of the ocean admitting of rock deposition at thi period, never extended so far north by many miles as in th period of the Burlington limestone.

The Warsaw Archimedes limestone appears to have been nearly coextensive with that below, so far as known at present. The St. Louis limestone extends northward also, nearly or quite to the same limit. but only in a thin brecciated or conglomeratic mass which has been rarely recognized above the lower rapids of the Mississippi. It is only on descending the valley to the neighborhood of Alton that this rock appears in any considerable force.

To these limestones succeeds the sedimentary deposit of ferruginous sandstone, which in the river valley is not known far to the north of St. Louis, while the succeeding Kaskaskia limestone becomes important in the vicinity of the Kaskaskia river, and is known in the interior as far north as Prairie de Long, and increases in force as we go southward.

We have most clearly therefore the evidence that the limits of the ocean admitting of calcareous deposits was gradually contracting, at least in the direction from north to south, leaving the more southern portions as the areas of greatest development for these limestones.

Some interesting inquiries are suggested by these facts, and at the same time they afford in some degree the solution of a difficulty which has heretofore been unexplained.

It is well known that no limestone of the age of those here described, occurs beneath the coal measures on the western side of the Appalachian coal field north of the Ohio river; nor upon the eastern side of the same field, till we reach the central part of Virginia. The same is true of the coal fields of Nova Scotia and New Brunswick, according to Prof. Dawson, the northern sides exhibiting no underlying limestones, while these rocks do appear coming out from beneath the coal measures on the southeastern side. The same phenomena occur in regard to the northern portions of the Illinois and Iowa coal basins.

At the same time I have ascertained in the most satisfactory manner that the coal fields of Iowa, Missouri and Illinois, rest unconformably upon the strata beneath, whether these strata be the Carboniferous limestones, the Devonian, the Upper Silurian, or the Lower Silurian rocks. In either case the measures are unconformable, differing only in degree.

It would appear, that at a period long preceding the com-

mencement of the carboniferous limestone deposits, the ancient ocean began to contract its area; that this contraction was due to the uplifting of the older rocks upon the north; and that this state of things continued throughout all the period of the limestone deposits. It would also appear, that during this period or at its close, and previous to the deposition of the coal measures, the older strata, becoming uplifted and at some points broken by faults, acquired in many places an inclination of from ten to thirty degrees; that denudation to some extent wore down the inequality caused by this uplifting agency, and produced other irregularities of the surface.

The coal measures extend much farther to the north than the northern limits of the Carboniferous limestones, and are spread out over the thinning and slightly inclined edges of these beds, and over the more disturbed and more highly elevated edges of the rocks of the preceding periods; so that the coal measures rest respectively upon all the formations from *lower Silurian* to the *Carboniferous limestones.* The only explanation we can offer is that the area of the ocean which had contracted up to the time of the coal period, was afterwards extended by the sinking of the land, allowing the sandstones and shales of the coal measures as well as subordinate beds of limestone, to be spread over much wider areas than the preceding formations of carboniferous limestone.

This accounts for the absence of the carboniferous limestones on the northern margins of all the coal fields.

It is true, however, that the carboniferous limestones of Nova Scotia have a more northerly extension than the northern limits of the Appalachian coal field; but if these limestones of Nova Scotia be of the same age as those at the southwest, their occurrence there may be due to the direction of the ancient sea margin or the line of ancient coral reefs. It appears that this direction may have been from the southwest to the northeast, at least for that portion of country east of the Cincinnati axis; while to the west of that line the carboniferous limestones make a northerly bend, as if at that period that part of the ocean now the valley of the Mississippi admitted of a greater extension of the coral reefs in that direction.

This view, sustained by facts, while it offers a general solution of the difficulty respecting the non-occurrence of carboniferous limestones on the northern margins of all the coal measures, at the same time suggests an explanation of the greater accumulation of conglomerates and coarse materials in the same position.

The high angle of elevation of the older strata, and the inequalities of surface on which the western coal measures rest, prove conclusively that extensive denudation had taken place previous to the coal period; and this fact should suggest a cau-

tion in our conclusions regarding the vast influence of modern denudation upon the surface of the globe.

Among the remarkable and interesting consequences of this ancient denudation, it is not uncommon to find depressions among the inclined strata of the Silurian rocks, filled with regular coal deposits, lying usually nearly horizontal, or with a slight dip varying from the surrounding rock. These outcrops, which sometimes occur in ravines or the valleys of water-courses, have all the aspect of regular measures: from the direction of the bedding they would penetrate the bank, but are nevertheless cut off by the inclined strata frequently within a few yards. Isolated masses of this kind are not uncommon, both in Iowa, Illinois and Missouri, lying at the foot of elevations, and apparently penetrating the adjoining higher ground. These, in many instances in Missouri, have been worked entirely out, and proved to have no connection whatever with the adjoining beds, or with any other coal in the vicinity.

In several localities on the Mississippi in Iowa, the older rocks dip to the northward at an angle of from ten to fifteen degrees, presenting the outcropping edges at points more or less distant from each other, while the intermediate space is occupied by strata of the coal measures, lying in a horizontal position. These phenomena have been mistaken for faults, but their origin is far different; and the coal measures have apparently never been disturbed from the time of their deposition.

A still more interesting exhibition of phenomena attendant upon this condition of the strata, and consequent upon this ancient denudation, is the occurrence, in the limestones of the age of the Hamilton and Upper Helderberg groups, of rounded or irregular masses of clay, like the underclay of coal seams. These masses which are seen in sections along the river, and in quarries, often present simply the appearance of a spheroidal mass of clay, sometimes a narrow seam of clay connects this mass with a similar one in a higher bed of limestone; and it not unfrequently happens that these clay seams, which are always vertical to the bedding of the limestone, may be traced to the surface, where the clay mingles with the superincumbent materials of the drift, as if having the same origin. On examining the parts of contact between the clay and limestone, we find the former adhering closely, and when separated, the limestone still retains a striated coating of the clay. The clay is laminated, and the laminations are curved or irregular, but never parallel to the lines of bedding in the limestone.

A single instance of this character satisfied me that these masses of clay were of subsequent deposition to the limestone, and that they filled cavities which had been made by denudation like modern caverns in limestone. This example was seen in the vertical face of a quarry presenting an elevation of 30 or 40

feet. From the loose soil above is a depression at the surface of the limestone; this is the commencement of a broad funnel-shaped opening, which gradually narrows below till within 10 feet of the bottom, where it spreads out on one side; having an irregular arching roof with numerous small archings and an unequal floor. Its extension to the left had been in part cut off. This cavity from top to bottom is filled with hard clay like the underclay of coal seams. At the mouth of the funnel it is of a reddish brown hue, but soon becomes of the ordinary gray color below.* The laminations of this clay, in the upper part, conform to the curvatures and irregularities of the roof of the ancient cavern, and exhibit every appearance of having flowed in while in a semi-fluid condition; while the hydrostatic pressure of the mass above, operating through the deep funnel, had forced the soft mass against the roof, causing it to assume in its laminations the same curvatures and irregularities.

In the midst of this mass of clay was seen the impression of a large Euomphalus, quite distinct from any fossil known in the surrounding rock, and very similar to a carboniferous form. The shell itself was not seen. With this exception, no remains of fossils were observed in the clay at this locality.

It seems impossible therefore to resist the conclusion, that subsequent to the uplifting of these rocks, the denudation of their surfaces and the wearing into caverns, the materials of the coal measures were distributed, filling these cavities, and depositing the successive members of the coal series upon the surface of these older rocks.

If any thing were wanting to complete the chain of facts, and carry the most conclusive evidence, it is found in a section near Iowa city. In a cliff of limestone, of the age of the Upper Helderberg of New York, where the strata are nearly horizontal, we have the following phenomena. Along the line of separation between two beds of limestone appears a black band extending for thirty or forty feet; beneath this, and of less horizontal extent, is a thicker layer of clay, precisely like that of the cavities before described, and of the character of underclay; still below this, and occupying the depth of the cavity, is a coarse sandstone. This sandstone follows in its lines of lamination or bedding the curvatures of the limestone upon which it lies, gradually filling up the cavity, and extending its laminæ above. Upon this comes the underclay filling the upper and broader part of the cavity, and having a greater horizontal extent than the sandstone below. Above this underclay, stretching for several yards upon each side and filling the open seam between the layers of limestone, is a band of black carbonaceous mud, the lower part slaty,

* The reddish brown color is simply due to infiltration from the ferruginous drift above.

and the upper part having the character of *cannel coal.* Here we have all the phenomena attending a coal-measure seam of coal. The sandstone, the underclay, and the seam of coal resting upon the latter, and, as if to complete the analogy, the slaty portion of the seam contains *fish teeth* of carboniferous character. All this is enclosed in limestones, which, in the State of New York, where the series is more complete, lie at a depth of more than 5,000 feet below the coal measures.

In this instance the explanation is clear enough. It is only a little more perfect in its members than the preceding case, and the aperture of admission is not visible in the same exposure. The coarse and fine sand were first transported, and falling through the fissure in the rock, continued in deposition in this cavity, while a bed of similar sandstone was being formed outside, and upon the bed of the sea. This ceased, and then came the clay which was continued in like manner, while the underclay of an exterior coal bed was in process of deposition. Lastly the carbonaceous mud derived from a coal seam, or the materials forming one, were filtered through the fissure and spread out in the narrow seam below.

There has been no mingling of the materials as if resulting from the breaking up of a coal seam at a later and modern period, and the subsequent filtration through a seam into this rock. Every part is as distinct as in the coal measures elsewhere; and it could only have resulted from a participation in the causes then operating to produce those extensive beds of sand, clay, shale, and coal, which make up the coal measures.

It should not be forgotten that this point is near the northeastern margin of the coal measures, and beyond the limits of any known productive coal seam; a few isolated patches of sandstone and shale being all the remaining evidences of the extension of this series in that vicinity.

The fissures and caves occupied by the lead ores in Wisconsin, Illinois, Iowa and Missouri, are apparently of similar character and origin; the period of their production being a point of discussion. Whatever may be said to the contrary, it appears still very certain that these lead-bearing fissures have no connection with the rock below; and also that the character of the fissures, with the materials filling them, indicates an action from above. That these cavities were excavated, and subsequently filled or partially filled with the ores of lead, zinc, and iron, by infiltration from above, seems, as elsewhere stated by the writer,* as well settled a problem, as that the coal seam just noticed is due to infiltration from above. The age of the rock in which the lead occurs is not a question affecting the origin of the mineral

* The same views, in reference to the origin of the lead ores, are entertained and have been published by Mr. J. D. Whitney.

matter, for while in Iowa, Wisconsin and Illinois, the lead-bearing rock is an upper member of the Trenton limestone period, it is in Missouri the Calciferous sandstone, a rock much older than the Trenton period. The mode of occurrence of the ore is similar in both places.

The fact that the calciferous sandstone in Missouri is the lead-bearing rock, and that sometimes in Upper Iowa and Wisconsin the same rock contains some lead ore, has induced the belief that the origin of the ore is from below. It is true that the calciferous sandstone is spread over large areas of country on the north of the productive lead region of Illinois, Iowa, and Wisconsin; but thus far it has been found to contain no lodes of value. It is likewise less cavernous than the lead-bearing or Galena limestone, and far less so than the same rock in Missouri. From what we know, it appears that neither the Carboniferous limestone nor the coal measures ever reached so far north as the northern lead-bearing rock, while these strata occupy the country around the lead region of Missouri, and outliers of the coal measures often rest directly on the Calciferous sandstone, the lead-bearing rock of that State.

There is therefore strong presumption in favor of regarding these fissures and caverns, whether filled with mineral matter or otherwise, as having been formed during the Carboniferous period, and previous to the deposition of the coal.*

The elevating forces which have raised the pre-carboniferous strata to their present inclination throughout the west, have had a determinate direction, and this direction has been from northwest to southeast, parallel to the great mountain ranges on the west, and at a nearly right angle with the great Appalachian chain on the east. So far as my opportunities permitted the determination of the direction, it is north 40° or more west.

In descending the Mississippi river we first notice that the strata rise and fall in broad undulations, which cross the direction of the valley from northwest to southeast. Still lower down we meet with more abrupt anticlinal axes, and in one of these at the Upper Rapids and below are several minor plications. Below Davenport we find considerable regularity; and between that point and Cap au Gris we again notice only broad undulations,

* In making this statement, the writer would not be understood to say that similar fissures and caverns may not have been produced in these rocks during the modern or intermediate periods, through the drift and other degrading agencies, which at the same time may have removed the clay or other mineral matter from caverns of previous date, rendering the determination of the period of their origin, a matter of considerable difficulty. At the same time, the fissures filled with mineral matter, accompanied or unaccompanied by a peculiar clay quite different from the drift materials of the region, or with this clay alone, or with indurated clay like the underclay of coal seams, either with or without the presence of sandstone and coal, all point to a period long anterior to that of the modern drift.

which reveal successively all the strata from the Carboniferous limestone to the lower Silurian rocks. In approaching Cap au Gris from the north, there is a gradual rising of the lower strata, so that the Trenton limestone is beautifully defined for a considerable distance; and beneath it lies a magnesian limestone, apparently of no great thickness. The dip to the northeast increases, and from beneath these limestones the sandstone rises in a bold escarpment continuing for three-fourths of a mile, and presenting several hundred feet of thickness. This elevation suddenly declines to the southward, and we find the Burlington or lower Carboniferous limestone standing vertically by the side of the lower sandstone. The limestone soon assumes a steep and gradually a more gentle dip to the south, and the succeeding members come in successively. This fault, which is in fact an anticlinal axis, has a northwest and southeast direction, and, according to the observations of Mr. Worthen, extends far into Illinois.

Below St. Louis, in the vicinity of Selma, there is another decided anticlinal axis, bringing up the lower sandstone. According to the Missouri Report, the lower limestones and sandstones are again brought up in the vicinity of Bailey's Landing; but I have personally examined the strata at this place only so far as to decide that the Upper Silurian strata appear from beneath the Upper Helderberg and Hamilton groups, beyond which the Carboniferous limestones appear to come on unconformably in the synclinal axis.

Still another axis of very decided character brings up the Trenton limestone in great force at Cape Girardeau on the Missouri side, and at Orchard Creek below Thebes on the Illinois side. This axis affects all the southern portion of Illinois below a line drawn from Fountain Bluff on the Mississippi to near Golconda on the Ohio. In some parts of its course this axis would appear to deviate from the meridian no more than 35° west of north, and 35° east of south. In a country, however, where denudation has taken place to such an extent, and succeeding strata are spread over the uplifted edges of those below, it is not always easy to determine the exact direction until traced over a wide extent.

That these low axes crossing the Mississippi are the results of the great movement which elevated the fundamental strata of the western mountain chain, we can have little doubt. The forces that there acted upon the huge pile of sedimentary strata, raising them into high mountain chains, here operated upon a thickness of a few hundred feet; and we may have not only the dying out of the elevating force, but also the diminished thickness of the strata for the subject of its action. If the action which elevated the great mountain chains of the West operated only on the palæozoic strata, the greater amount of material in that direction

would give greater elevation to the ridges, which under similar force would die out in the Mississippi valley for want of material to be elevated.

The discussion of this part of the subject, however, does not properly enter into the present paper, and will be postponed to another occasion.

A few words may express the general features of the series of these limestones on the south of the Ohio. All the members, with the exception of the higher or Kaskaskia limestone, gradually thin out to the south.

The "*Silicious group*," as it is termed in the Geological Report of Tennessee, there lies at the base of the Carboniferous limestone. This group is simply an extension of the cherty beds lying between the Burlington and Keokuk limestones, and which become largely developed in the south. The Burlington limestone is rarely seen occupying a few feet of thickness beneath the "silicious group," and is usually not recognized as a distinct mass. The Keokuk, Warsaw, and St. Louis limestones have thinned out so far as to form no important feature in the series; while the Kaskaskia limestone predominates over the whole country, and is there the great "Carboniferous limestone," yielding its abundance of Pentremites and Crinoids throughout its extent in Tennessee and Alabama.

ART IX.—THE GROTTO OF ADELSBERG.

THE celebrated subterranean cavern which bears this name, is situated about 2½ miles east of Trieste, and on the post road from that city to Plansna and Laibach. Its length as far as it has yet been explored, is upwards of two miles. It is probable, however, that the end of this vast cavern has never yet been attained, and that its extent is far beyond what modern explorators have supposed. From end to end it abounds in natural beauties, and is at once the most magnificent and the most extensive in Europe. It is, unfortunately, but little frequented by travellers, who, in omitting it lose one of the most magnificent natural scenes of the kind in the world.

The following description of this celebrated subterranean grotto I have condensed from materials supplied me, which have been translated from German into English by my neighbor, Dr. Charlton.

The grotto comprises two large divisions, viz., "The Old Grotto," and the new, or famous "Crown Prince Ferdinand's Grotto." Up to the year 1818 the old grotto was the only ex-

plored portion of this vast cavern. It was there that Valvasoi saw the wonderful demons and genii of the mines, and there that he experienced those sensations of horror and awe, which he has so vividly described in his work "Die Ehre des Herzogthums Krain." It was there, too, that some unknown traveller having lost his light, and consequently all knowledge of his way, laid himself down to meet the horrible fate which awaited him, and to this day his petrified skeleton remains, "a warning and a tale." Upon the wall immediately above it are inscribed the names of former visitors to the grotto, some of them are not less than four hundred years old, but beyond their antiquity they possess little or no noticeable interest. In a short time these and all the old grotto contains will be things of remembrance; the entrance to that portion of the cavern having become nearly, if not wholly inacessible. The constant formation of the stalactites, tends gradually to narrow the point of ingress, and to such an extent had this been accomplished when the writer visited the place, that a tolerably stout man might in vain have attempted to enter.

The other portion of this vast subterranean opening is that to which we intend particularly to allude, and may be said to commence at the Monument of Kaiser Franz. This structure, situated at one extremity of a spacious hall, ninety feet high, and a hundred and forty-four feet wide, is a huge unwieldy pile of masonry, erected to commemorate the visit of the Emperor Francis the First, and, till the year above mentioned, was supposed to form the extreme southern boundary of the grotto. In that year, however, the modern division of the cavern was discovered by a somewhat singular accident. Inspector Von Lôwengreif, anxious to afford their majesties, the Emperor and Empress of Austria, the spectacle of a complete illumination of the vast hall in which the monument is placed, had constructed, with immense difficulty and danger, a staircase down the perpendicular face of the precipice to the edge of the river Poik, which enters the cavern a short distance below the outer doorway. Having thrown a bridge across the water, and thereby gained the opposite side, he planted his lanterns in a position to produce the desired effect. This done, he naturally stood for a few minutes contemplating the sublime scene before him. The glare of the lanterns rendered nearly every nook and cranny of the lofty apartment visible, and Lôwengreif, casting his eyes upwards, was surprised to see, at a height of about fifty feet, a recess of considerable dimensions, the entrance apparently to another spacious chamber. The nature of this large opening he determined to ascertain at all hazards, but for upwards of a year, the difficulty of procuring materials to accomplish the ascent, deterred him from prosecuting the enterprise. At length, by dint of great skill and perseverance, he completed his object, and thus paved the

way for subsequent and successful explorations into the heart of this magnificent cavern.

The modern visitor, after crossing an elegant wooden bridge, beneath which the impetuous waters of the Poik rush and roar, ascends a steep flight of stairs—comprising no less than eighty-two steps—to the opening discovered by Von Lôwengreif. Having entered a rough and massive portal, he finds himself in a large arched vault, and surrounded on all sides by stalactites of every conceivable form and size, many of them being of dazzling brilliance and surpassing beauty. The sublimity of the scene is materially enhanced by a deathly silence, which pervades the whole apartment. The murmuring waters are hushed, the dropping of the stalactites is no longer audible, and, save the echo of a voice or a footstep, an unbroken stillness reigns. In the main avenue, which diverges considerably to the right of this chamber, are some of the finest stalactites in the Grotto. In one place the stalagmite from the surface and the stalactite from the roof have united, forming a unique and curiously-formed pilaster in the very centre of the passage. At another spot large lobe-like masses of stalactite are suspended from the arched vaulting by a slender stalk, so that, viewed by the flickering and uncertain glare of the torches, they bear so exact a resemblance to the hams and flitches in a bacon-factor's shop, that the visitor can readily agree to the name of the "Fleischbauk," Butcher's Bench, which has been bestowed upon them. A little further on is a very pretty, though somewhat small, recess, named the "English Garden." The floor is entirely covered with beautiful white stalagmites, from three inches to three feet in height, and, from their uniform cylindrical shape, they really resemble the formally-cut box and yew trees of an old-fashioned English lawn or shrubbery.

Re-entering the main passage, without tarrying to notice the "Dolphin and Lion" and "the Throne," which, though striking, are by no means extraordinary, a pair of very singular stalagmites present themselves. They bear the form of two hearts placed side by side, and so minute is the resemblance that the hand of the experienced sculptor could scarcely have produced more accurate models. A brisk walk brings the visitor to another subterranean wonder, the Iron Tree, or "Stock am Eisen," so called in allusion to the famous tree in Vienna, into which every apprentice had to drive a nail. Various objects of interest here present themselves in succession, but none call for particular mention until we arrive at the "Tanzsaal, or Tournament Place." The Tanzsaal is a hugh vaulted cavern, the roof of which is exceedingly lofty, and traversed by massive ribs of rock not unlike the vaulting of some old Norman cathedral. Its length is a hundred and fifty feet, and it gains much in grandeur on ordinary occasions by the impracticability of producing the

requisite amount of light to render the whole of its gigantic proportions visible. Once a year, however, it is brilliantly lighted up for a subterranean festival, when it becomes the resort of the peasantry for many miles around, and is the scene of boundless mirth and pleasure.

After leaving the Tanzsaal, the stalactites become less numerous and frequent, and the visitor is conducted for some distance along a gallery of naked rock, the roof of which, in various places, is fifty or sixty feet above the level of the floor. From time to time, however, stalactites of varied and striking form appear, and when this occurs the objects they are supposed to represent are seen to greater advantage from the circumstance that all around and above them is dull, unvarying rock. One group, so isolated, is called the "Tabernacle," from its resemblance to the Gothic shrines of the Blessed Sacrament, such as one sees in the Church of St. Lawrence at Nuremburg. Another has received the unromantic name of "Die aufgĕhangene Wasche," or the "linen hung up to dry;" and a third is called "the Charcoal Furnace." Not far from this latter is an enormous stalactite pendant from the rocky roof about eighteen feet, and, at its extremity, twelve or fourteen feet in breadth. In the very centre of this mass is an apparently dissimilar substance, of a deep brownish red color, and in shape a parallelogram. It appears to be let into the stalactite, the latter forming a kind of framework around it, hence it has received the name of "the Picture," and as its color is a deep red, whilst the stalactitic frame is a remarkably brilliant white, it not inappropriately bears that designation. Immediately beneath it a huge block of stalagmite ascends, and nearly, if not quite, joins the mass above, giving the whole the appearance of a massive obelisk raised in honor of some redoubtable demon or spirit hero, whose triumphs were to have been imperishably inscribed upon the central tablet, or configured around the sides of the column itself.

Passing by "the Mummies" and "the Grave" as objects too melancholy for contemplation in this cavern of so many beauties, we reach "the Ruffles." This beautiful formation is a curtain of alabaster, so thin and fine that the flame of the torch is distinctly visible through its transparency. The country people call it "the Shirt Frill," and its vandyked form and wavy outline present an appearance somewhat similar to that old-fashioned article of dress. Immediately opposite will be observed a column of stalagmite broken across about four feet from the ground. Its upper part leans against the wall of the Grotto, and a smaller pillar has begun to form directly above the fracture from the same dropping which, in all probability, deposited the original column. A short distance further are two tall pillars, named the "Greater and Lesser Cypresses," the latter of which is twenty-one feet in height. The next object of interest, and one which

perhaps surpasses in elegance the Shirt Frill, is "the Curtain." The magnificent stalactitic drapery which bears this name is pendant from the limestone rock, at a height of about nine feet. Its breadth is not more than a yard, and its thickness from three to four inches. Nothing can exceed the marvellous delicacy and gracefulness of its folds, while to render the illusion more complete, a stream of water strongly impregnated with oxide of iron has tinged its edge with a most exquisite brown and red border four inches wide. From this point to the Calvarien Berg or "Mount Calvary," the scenery is of the most monotonous character. The principal object of interest in the route is a little pool, not that of itself it is any thing remarkable, but because it contains some living specimens of the Proteus Anguinus, a strange flesh-colored, lizard-like, little animal, furnished with gills and feet, destitute of eyes, but having small points, and possessing an excessive development of head. The animal is supposed to be confined to this and the Magdalenen Grotto, a short distance from Adelsberg; hence the curiosity it excites.

Sir Humphrey Davy says:—"At first view, you might suppose this animal to be a lizard, but it has the motions of a fish. Its head, and the lower part of its body and its tail, bear a strong resemblance to those of the eel; but it has no fins, and its curious branchial organs are not like the gills of fishes; they form a singular vascular structure, almost like a crest, round the throat, which may be removed without occasioning the death of the animal, who is likewise furnished with lungs. With this double apparatus for supplying air to the blood, it can live either below or above the surface of the water. Its fore feet resemble hands, but they have only three claws or fingers, and are too feeble to be of use in grasping or supporting the weight of the animal; the hinder feet have only two claws or toes, and in the larger specimens are found so imperfect as to be almost obliterated. It has small points in place of eyes, as if to preserve the analogy of nature. It is of a fleshy whiteness and transparency in its natural state, but when exposed to light its skin gradually becomes darker, and at last gains an olive tint. Its nasal organs appear large; and it is abundantly furnished with teeth, from which it may be concluded that it is an animal of prey; yet in its confined state it has never been known to eat, and it has been kept alive for many years by occasionally changing the water in which it was placed. It has been found of various sizes, from that of the thickness of a quill to that of the thumb, but its form of organs has been always the same. It is surely a perfect animal of a peculiar species. And it adds one instance more to the number already known of the wonderful manner in which life is produced and perpetuated in every part of our globe, even in places which seem the least suited to organized existences. And the same infi-

nite power and wisdom which has fitted the camel and the ostrich for the deserts of Africa, the swallow that secretes its own nest for the caves of Java, the whale for the Polar seas, and the morse and white bear for the Arctic ice, has given the Proteus to the deep and dark subterraneous lakes of Illyria,—an animal to whom the presence of light is not essential, and who can live indifferently in air and in water, on the surface of the rock, or in the depths of the mud."

In another portion of this dreary avenue, and a little further ahead, the calcareous matter seems as if it had been suddenly arrested whilst rolling in a liquid state over the rock, and its appearance is not unlike that of a waterfall. As a relief to the tedious monotony of the road, this is a rather striking object; in any other part of the Grotto it would receive but little attention. After leaving it, jagged abutments of limestone and uncouth projections of the naked rock constitute the whole of the scenery until we reach the gate of the Calvarien Berg. Once there, the view more than compensates for the dreary length of the passage. The roof rises to an immense height, while the surface is studded with innumerable stalagmites of the most grotesque shapes and fantastic hues. The prevailing colors are white and red, and it is somewhat singular that the white stalagmites invariably form the sponge-shaped and tubular masses, while the red shoot up into tall and slender pillars. Many of the latter are deeply and uniformly grooved, while others are like buttresses with regular offsets. Indeed, nearly every style of pillar and column is represented, varying in shape according to the position from which the stalagmite is viewed.

And now having left "The Difficult Pass" behind him, the visitor arrives at the foot of Mount Calvary, a stalagmitic hill of large proportions. It retains the singular name of Calvary in compliment to the pious feelings of the early exploratory, who invested the whole apartment with sacred interest, from the fancied resemblance it bore to the memorable scene of the crucifixion. A kind of central pillar is called "The Redeemer's Cross;" another pillar is called after St. John; a third is named "St. Stephen's;" while in the vicinity are various objects which, suggestive of different incidents in the closing scene of Christ's life, have received appropriate appellations. Here the visitor may tarry long, and feast his eyes with fresh marvels; the resources of the Berg being, comparatively speaking, unlimited. If he have a taste for exploration he may travel the passages which abound in the locality. Or, on the other hand, returning to the main avenue, he may proceed for a quarter of a mile along the bare rock to the supposed extremity of the cavern, a small lake, over which an adventurous Englishman not long since swam; or, like hundreds of others, he may hasten back to the blessed light of day and the pure river breezes which await him

above, edified by what he has seen, and influenced by any feelings but those of regret at having spent the greater part of the day at the far-famed Grotto of Adelsberg.

ART. X.—REPORT ON THE COAL FIELDS ON DEEP RIVER IN NORTH CAROLINA—THE FOOSHEE AND STREET ESTATES. By DR. CHARLES T. JACKSON.

FROM the most recent researches, it appears that the Deep River coal is contained between strata of triassic and liossic geological age, as proved by the fossils discovered. It also appears that the coal measures are extensive, exposing an out-crop of more than sixteen miles in extent, following the curvatures of the out-crop of coal. It is also now fully ascertained that the coal extends under Deep River, and through the plains to the south-eastward, with an average dip of not more than 16 degrees; while at the out-crop the dip is sometimes as high as 30 degrees, a steeper dip being more usual in coal basins or troughs at their out-crops than elsewhere.

At the time of my former visits to Deep River, the out-crop of the coal had not been traced beyond Murchison's, but lately, by sinking shallow pits, of not more than 20 feet in depth, the coal was found on the land of Mr. Fooshee, on the south-west side of the river, near the ford. I examined the coal at these openings, and found it to be good, and highly bituminous, and not disturbed by trap-dykes. The bed exposed measured by me was near the out-crop, 4 feet 9 inches thick, and was underlaid by the same fire-clay that lies under the thickest bed at Egypt plantation. The coal in this pit has not an inclination of more than 15 degrees to the south-eastward.

We took out a quantity of the coal and burned it at Mr. Fooshee's in the evening, and found it coked readily, and gave off a large yellow flame, and made a hot and lasting fire. The coal has been discovered in four pits sunk on Mr. Fooshee's estate. Street's plantation is underlaid by this coal, and it can there be struck by a shaft of reasonable depth, and will be easily mined. By consulting Professor Emmons' Geological Map of the Deep River Coal Formation, you will see exactly the position of the coal on the two estates I have examined, and it is not necessary for me to enter into any more details, since I gave you the copy of that map kindly furnished me by Professor Emmons.

The Egypt coal mine is regarded as important, since by the shaft sunk there by Mr. McLean, the extent of the coal beneath the plains was proved beyond doubt. This shaft is 462 feet deep, is admirably constructed, and cuts through 5 feet 4 inches of excellent coal.

The section of the beds at the bottom of the shaft is as follows:

Coal	4 feet,
Clay and Black-band Iron ore	16 inches,
Coal	22 inches,
Shale and Fire-clay	6 inches,
Coal	7 inches,
Shale and Fire-clay at bottom.	

Dip of the coal is from 16 to 20 degrees south, 10 degrees east.

The shaft is 15 feet by 8 feet square, is well cut, and properly timbered, and has a steam engine of forty horse-power, for pumping water, and for raising the coal. When the new boiler is set, the pumping will be done by a separate engine, and then the hoisting of the coal can be done by the other engine with great rapidity, it being capable of raising a ton of coal every two minutes.

I have, since my return home, made a chemical analysis of a sample of the coal from the Egypt mine, and find it to yield

Carbon	63.6
Illuminating Gas	34.8
Red-brown Ashes	1.6
	100.00

The coke amounts to 65.2 per cent., and is of excellent quality and quite bulky.

This is a good gas coal, and is also suitable for the hollow fires of forges, and for all the usual purposes of fuel.

The black-band iron ore, I found to consist of

Coal	31.30
Bitumen and Water	8.81
Peroxide of Iron	47.50
Silicious Earth	9.00
Sulphur	3.39
	100.00

The carbonate of iron or the iron ore balls and crusts is good, and is free from sulphur, and will make good iron. This ore is quite abundant in the coal field, and probably an ample supply for a furnace may be obtained.

So soon as the slack-water navigation of Deep River is completed, which the engineer is understood to have promised to complete by October next, the coals of Deep River will be brought to market at a low cost, and they will sell readily in all our larger towns and cities for gas-making, and for other uses. A railroad to Fayetteville is understood also to be under contract, and this will afford another means of transportation of the

coal to navigable water. The Deep River Coal Fields are destined ere long to take a high rank among our available coal regions, and we cannot but urge the hastening of the means of conveyance of these valuable coals to the seaboard.

COMMERCIAL ASPECT OF THE MINING INTEREST.

Money in Wall street for the moment is a drug, and it requires a strong legitimate temptation to disturb it from its place of safe-keeping. Capitalists remain very indifferent to employing at present, still we can recognize a more general disposition in favor of the mining interest, and the necessity of more fully developing our mineral resources is daily made more apparent to the public. Mining shares remain much the same as at our last report, with a slight tendency upwards.

NEW YORK COAL MARKET, Dec. 9, 1857.

The supply of Foreign Coal is not large, but is fully equal to the demand, which has continued limited, owing in part to the very mild weather. Liverpool is nominal at $8 for Orrel, and $10 50 for Cannel. We hear only of a sale of a cargo of Sidney at $5 50, cash and 4 mos. Domestic has sold sparingly, and with the continuance of canal navigation to a late period, we are likely to have a full stock at the close of the season; prices are hardly so firm. The demand for East has fallen off, and our quotations for cargoes must be regarded as nominal; sales by the cargo at $4 15 a $5 05; and from yard at $5 15 a $5 62½ per ton.

BOSTON COAL MARKET, Dec. 7, 1857.

[From the *Boston Courier* of December 8.]

In Sidney and Pictou Coal there have been further cargo sales at $7 12½ a $7 25 per chal., cash. The sales of English Cannel have been at $12 50 a $14 00 per chal., for large and small lots. Domestic is in fair supply, the market has not changed perceptibly. Anthracite has been in steady retail demand at $7 00 per ton.

NEW YORK IRON MARKET, Dec. 9, 1857.

The demand for all kinds of Iron is quite limited, the trade only purchase from hand to mouth to supply their most urgent wants, and at prices which would be no real guide to the market for large lots. Scotch Pig commands $28 a $29, 6 months, for lots of two, three and five tons, but if whole parcels were pressed on the market, the article would not command $26, and cash buyers can be accommodated at $22. None of the principal importers, however, are anxious sellers at these low rates. Common and refined Bars are still uncalled for, and quotations are altogether nominal. The trade are being supplied at $52 and $62, 6 mos., respectively, but no whole parcels could be placed at any thing near these figures. English Sheets range from 3½ to 4½ cts. for singles, doubles and triples. Other kinds are dull and nominal.

BOSTON IRON MARKET, Dec. 7, 1857.

[From the *Boston Courier* of December 8.]

The market for Pig Iron continues very dull, and the sales have been moderate at $27 a $28 per ton, 6 mos., for Gartsherrie and other brands, Scotch, No. 1. American Pig is selling at $26 a $27 per ton, 6 mos. In Bar Iron sales of common and refined English at $55 and $65 per ton, 6 months. Sheet Iron is quiet.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

SCHUYLKILL.

The quantity of coal sent by railroad and canal from Jan. 1 to Nov. 26, 1857, is:—

	Tons.
By Railroad	1,685,360
" Canal	1,206,522
Total by Canal & R. R.	2,891,882

Shipments to same period last year:

By Railroad	2,073,875
" Canal	1,113,826
	3,187,695
	2,891,882
Decrease in 1857, so far	295,813

LEHIGH COAL TRADE FOR 1857.—*From the Miner's Journal, Pottsville.*

Total amount of shipments for 1857, to Nov. 21st:

By Canal,	Tons.
Lehigh Coal and Nav. Co.	374,780
A. Lathrop and others	3,465
Spring Mountain Mines	36,901
East Sugar Loaf do	23,787
Coleraine do	42,[illegible]
Stafford do	510
N. York and Lehigh Coal Co.,	26,494
German Penna. Coal Co.	9,113
South Spring Mountain Coal	17,873
J. B. McCreary & Co. N. S. Mt. Coal	11,713
Beaver Meadow Coal Co.	4,259
Hazleton Coal Co.	83,388
Cranberry Mines	62,791
Diamond Mines	27,154
Council Ridge	35,104
Mt. Pleasant Coal Co,	10,044
Buck Mountain Coal Co	63,701
Wilkesbarre Coal Co.	6,531
Wyoming Coal	10,726
Hartford Coal Co.	20,039
Total	871,241

LEHIGH VALLEY R. R.

Spring Mountain Mines,	110,030
East Sugar Loaf do	83,474
N. York & Lehigh do	34,113
Council Ridge do	62,009
German Penna. do	6,394
Coleraine & Stafford do	42,855
Dolbin & Dehaven do	10,407
Hazleton do	52,131
John B. McCreary & Co	7,278
Mount Pleasant	64
	408,259
	871,241
Total	1,279,500

Shipments during same period, last year:

By Railroad,	155,733
By Canal	1,161,264
	1,320,997
	1,279 500
Decrease in 1857, so far	42,497

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the month of Oct., 1857:

	Month.	Tons.
Union Canal	14,085	144,429
Swatara Railroad	8,422	103,167

LYKENS VALLEY COAL TRADE FOR 1857.

Lykens Valley Coal Company	60,275
Short Mountain Co.	52,433
Total	112,708

LACKAWANNA COAL TRADE FOR 1857.

Coal transported over the Delaware, Lackawanna, and Western Railroad for week ending Saturday, Nov. 21st, 1857:

	Week.	Season.
Shipped North	2,090	177,908
" South	2,056	276,361
Total	4,146	454,269
Coal shipped to the same period last year		98,181

DELAWARE AND HUDSON CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Nov. 21st	469,908
Last year	495,730
Decrease this year	25,822

PENNSYLVANIA COAL CO.'S COAL TRADE FOR 1857.

	Tons.
Up to Nov. 21st	527,138
Last year	594,622
Decrease so far, this year	67,484

TREVORTON COAL TRADE FOR 1857.

	Tons.
Up to Nov. 21st	89,744

BROAD TOP COAL TRADE FOR 1857.

	Tons.
Up to Nov. 21st	65,589

MAYRYLAND COAL TRADE.

The Cumberland Telegraph of Nov. 26th has the following:—

"For the week ending Saturday, Nov 21, the Cumberland Coal and Iron Company's Railroad brought down tons of coal, and the Cumberland and Pennsylvania Railroad 4,187,06 tons, making a total from the Frostburg region for the week of 4,187,06 tons.

During the same period there were shipped over the George's Creek Coal and Iron Company's Railroad 4,653·15 tons, and over the road of the Hampshire Coal and Iron Company 771·07 tons, making a total for the week from the George's Creek region of 5,425·02 tons.

Total from the entire coal-field for the week 9,612·08 tons, and since Jan. 1st, 546,212 01 tons.

COAL IN KENTUCKY.

We have before us an account of an exploration made by two leading geologists of a portion of the State of Kentucky, covered by what is known as

the "Great Illinois Coal Fields." That part of the field which is within Hopkins County is now in possession of a company known as "The Mastodon Coal and Iron Mining and Manufacturing Company," and lies along the line of the Henderson and Nashville Railroad. The twenty thousand acres of land, chiefly in Hopkins county, Kentucky, owned by the company, as well as the additional five thousand acres on which they have mining privileges, occupy the southern margin of this most extensive coal-field in the position the most accessible for working, the most advantageous for drainage, entirely safe for the miner, and in near proximity to an important market for its valuable materials.

The explorations referred to cover no less than six distinct coal-beds within the region of the company's lands, and the mean aggregate thickness of the workable coal of good quality, imbedded, is stated to be about 25 feet. The agricultural character of the soil is also represented as better than that to be found in mineral region sand portions situated in the valleys, affords large and excellent timber, such as beech, maple, white oak, hickory, ash, elm, walnut, coffee-tree, etc., and exhibits fine crops of tobacco, probably averaging 1,000 pounds to the acre; while the uplands are excellent second-rate farming land, capable of producing, under good management, 800 pounds of tobacco to the acre, admirably adapted for wheat, rye, oats, and grasses, and doubtless suited for stock generally, but particularly for sheep; while there is also a very fair growth of timber, particularly oak, hickory, dogwood, and, occasionally, especially in neglected fields, sumach.

Intersected by a railroad, great commercial resources would be opened to the company it is thought, and also many of a manufacturing character. Lumber, shingles, staves, hoops, &c., oak and chestnut bark for tanning, sumach, &c., would be abundantly yielded.

In regard to iron, the indications are favorable, though the examinations are not sufficient to establish certainly the character of the metal. There are, however, abundant indications of argillaceous carbonate of iron in nodules, as well as of ochreous iron ores. On the subject of the importance of the coal trade and the particular advantages of this location, we copy from the report as follows:—

"In an average depth of 25 feet there would be due about 40,000 tons to each acre of the 20,000 acres included in the tract. The lowest price of coal at Nashville is \$4 50 per ton. Put it at \$2 50, or ten cents per bushel, and the product of one acre would be \$100,000, of which the profit would be \$50,000, the cost of working being but one cent per bushel, and the transportation to Nashville, eighty miles by railroad, 4 cents more. It has already been wagoned from the lands for 25 miles, and sold at Hopkinsville for 15 cents per bushel.

"The demand for coal between Louisville and the Balize is variously estimated. Some who profess to have examined the markets with care, have stated it as high as seventy millions of bushels a-year. 'It appears that coal, of which ten bushels are equal to a cord of cotton-wood, can be delivered on the lower Mississippi at thirteen cents a bushel, and yield a fair profit. This equals cotton-wood at \$1 30 a cord, or less than half its average price.' 'Fifteen dollars a cord for pine wood has been paid at New Orleans by Louisville boats. Five and six dollars a cord for inferior cotton-wood has been no unusual price, on the Mississippi.' 'This is certain, that the demand for coal will increase more rapidly than the supply. In 1845 the sales at the Cannelton and Hawesville mines amounted to only 213,000 bushels. *Now*, this quantity and more is required *every month*, when the river is navigable.' 'Long that skilful, thrifty boatman, Captain Sturgeon, could not be induced to use coal, except in his cabin. Now the Eclipse often leaves the Ohio with 10,000 bushels upon her decks, even to the displacement of freight.'

"But the steamboat and sugar-mill demand for the fuel of the lower Ohio will soon be inconsiderable when compared with its demand for manufactur-

ing purposes. In a few years the men of energy and capital in the West will wonder at their own blindness in not appreciating and profitably developing the immense natural advantages afforded by the minerals, the fuels, the subsistence, and by the easy transit on the lower Ohio for the manufacture of their own great staples. They will then understand the perspicacity of that veteran manufacturer and statesman, Richard Cobden, of England, who years ago declared that the chief seat of the cotton manufacture must eventually be on the coal-fields of the central west, where heat, power, iron, subsistence, transit, and material could be brought together and combined cheaper than any where else in the known world."

The Hopkins lands embrace the entire extent of the coal-fields through which the Nashville and Henderson road will pass. They are forty miles from the Ohio river, and the company expect to have in five or six months 100 barges and 10 steam tugs for supplying with coal the lower Ohio and the Mississippi as far even as New Orleans. The stockholders are men of reputation and wealth.

IRON AND ZINC.

RESEARCHES UPON THE INFLUENCE OF SULPHUR UPON IRON, AND THAT OF PHOSPHORUS IN PARTIALLY NEUTRALIZING THE ACTION OF THE SULPHUR; BY M. JANOYER.

[Translated from the Ann. des Mines, 6th vol., for 1854, p. 149, for the Amer. Jour. of Science and Arts, by W. J. Taylor.]

The deleterious influence of sulphur upon the qualities of the various kinds of iron, is a fact known to all persons engaged in metallurgy. Indeed, it is well understood that there is a very great difference between the irons manufactured with charcoal and those with mineral coal. These last are nearly all more or less "hot-short," although made from the purest ores. This bad quality of the iron is to be attributed generally to the presence of the sulphur in the mineral coal. Traces of sulphur that can scarcely be detected by analysis, are sufficient to render the iron "hot-short." Such irons, treated in the cold, are soft and tenacious; they are generally wanting in lustre in the fracture, and are welded with great difficulty; on the contrary, they are very brittle when hot, especially at a cherry-red heat, from which fact they have received the name of "fers de couleur."

According to Karsten (Manuel de Metallurgie), 0·03375 per cent. of sulphur is sufficient to destroy the property of welding in the iron, and to render it completely "hot-short." The latest analysis of the hot-short irons afford only one part of sulphur in 10,000 parts of iron.

The experiments made on this subject by this able metallurgist were carried out with great care. I will mention one operation on a great scale, which sustains his statement that the process by which the iron receives the sulphur, and which therefore is especially to be avoided, is the fusion of the ore in contact with the combustible mineral in the high furnace.

During the year 1850 I treated in the high furnace of L'Orme (Loire) only the ore from Privas (Ardeche), of which I have given the analysis (Annales des Mines, t. xx. 1855.) This ore is a hematite (anhydrous sesquioxide of iron), with shining lustre, unctuous to the touch, leaving upon the fingers a greasy coating of a red color. It is very pure, and of course well adapted to make iron of excellent quality. As evidence, it will be sufficient to consult the excellent memoir by M. Gruner, Ingenieur in chef. des Mines, "On the

ores of Privas and Lavoutte," (Ann. des Mines, 3e Serie). From pages 374 and 375 of this memoir the following analyses are taken, proving the purity of the Privas ores:

	Rich ores.		Average ores.
Sesquioxide of iron	83·9		69·2
Alumina	0·8		....
Carbonate of lime	7·4	Carb. lime, Mag., &c.	29·6
Silica and clay	6·5		7·0
Water	1·2	Water and butum	3·2
Oxide of manganese, trace			....
	99·8		100·9

According to the author, this ore contains scarcely a perceptible trace of sulphur and phosphorus. On page 376 he says, "Sulphur has in vain been sought for, and only the slightest trace of phosphorus has been detected. I ought, therefore, from the purity of the ores, to obtain an iron superior to any made in the neighborhood. Notwithstanding this, the iron afforded was moderately "hot-short." It presented, when cold, all the qualities of the best iron; soft, with black fibres, and without grain; it could be bent and twisted in every way without producing a flaw. On the contrary, at a cherry-red heat it was very brittle, and had lost all its tenacity.

The gangue of the ore was then assayed to determine if it contained barytes, for it is known often to occur with this kind of ore. * * * The experiments proved that sulphate of baryta did not exist in the gangue. The following are the results of two complete analyses of the ore in which all these researches for sulphur were made:

	Ore (Agatise).	Rich & luminated.
Volatile matters	1·4	6·4
Silica	11·0	12·4
Sesquioxide of iron	82·0	74·0
Alumina	1·6	1·0
Lime	3·6	6·0
Manganese, sulphur	none.	none.

It will be seen from the above that the "hot-short" property of the iron was not owing to the sulphur contained in the ore. It can, therefore, result only from the sulphids contained in the coke with which it was fused. The coke used in these experiments was invariably that of Peronniere, near Rive-de-Gier (Loire), the analysis of which (Annales des Mines, 1851, t. xx.) afforded 0·28 per cent. of sulphur.

The combustible material consumed at this time amounted to 22,000 kilogrammes (57,200 lbs.) every twenty-four hours; introducing into the furnace in this space of time 61k600 of sulphur (160 lbs.), which, according to a preceding memoir, is only able to go from the high furnaces as a proto-sulphid in the iron, or in the state of sulphide of calcium in the slags. These last being slightly silicious, the cast iron contained the principal portion of the sulphur.

It was, therefore, by no means impossible that this quantity should exert, in the high furnace, a very pernicious influence on the product, the cast iron obtained containing 0·003 per cent. of sulphur (20,000 kilogrammes every twenty-four hours, and supposing, which was not the case, that all the sulphur passed into the cast iron). This proto-sulphid of iron formed in the metal should be found, from its stability, in the wrought iron produced, so that there will then be more than sufficient sulphur to render the iron very "hot-short."

The objection may be made that the sulphur might have been introduced during the transformation of the cast into wrought iron during the puddling, in the presence of coal containing much pyrites, which permits a disengagement of half its sulphur at a red heat.

But I say still, that the passage of sulphur into the iron certainly takes place in the fusion of the ore in contact with the coke in the furnace stack; for at this time the same ore from Privas was treated in the same high furnace with charcoal, and under the same very careful conditions which were used in

fusing the same with coke. The slags were entirely silicious, like those obtained in the experiments with the mineral coal, which would favor the complete passage of the sulphur into the cast iron by preventing it from escaping as a sulphid of calcium, in the slags. The slag contained silica 53·77, alumina 17·93,* lime 28·30—100. * * *

The lime was found to be entirely taken up by the silica, and consequently could have no affinity for the sulphur. Nothwithstanding, the cast iron obtained, puddled in the same furnace with sand and coal,† by the same workmen, and under exactly the same conditions, gave an iron which presented in all points the characters of the best iron; its tenacity was perfect at all temperatures, presenting none of the characters of a brittle iron at a cherry-red heat.

Independent of the influence of the sulphur in coke, this experiment shows that it is important to demonstrate a fact practically; the action of sulphur, as will be clearly perceived, was in the fusion of the ore in contact with the combustible mineral, and *not* in the transformation of the cast iron into wrought iron by puddling.

It may hence be concluded that the sulphurous acid disengaged from the coal upon the grate of the puddling furnace and in reheating has no sensible effect on the iron. The sulphid which may be formed in the transformation of the cast iron into wrought iron at the surface of the metallic bath, is always where it is exposed to the oxidation, and, as M. Berthier has said, it combines with the oxide of iron to form oxysulphids, which separate from the iron in the state of scoria and scales. I have never assayed the scoria from the refining, without obtaining considerable quantities of sulphur. A careful analysis of a scoria from the refining that was very compact and contained no free iron, gave me 0·152 per cent. of sulphur.

These facts established, I sought to prevent this action of sulphur in the high furnace, at least in part, by combining the observations of the learned Karsten (according to whom the best irons appear to contain at least 0·002 to 0·003 per cent. of phosphorus) with the observations that I have made upon strong and hard irons made with coke mixed with pure argillaceous and phosphatic ores. These last-mentioned irons, possessing none of the properties of the "fers de couleurs," are produced under the same circumstances as the "hot-short" iron which I obtained when the ores contained not the least sulphur, and the coke employed for their fusion was equally sulphurous.

The very soft iron "hot-short" resisted fracture when cold; the two extremities of the bar were brought to within $0^{m}\cdot005$ (2-10 of an inch) of each other, without the least flaw or crack being distinguished in the bend, when the very hard iron has broken when the two extremities were within 5½ inches of each other (the two pieces of iron used in these trials were of the same length). On the contrary, when the very soft iron, heated at a "cherry-red," was bent to two points, say A and B, it broke without presenting the least tenacity, while the very hard iron perfectly resisted the trial when heated at the same temperature.

The very hard iron, although less good when cold than the very soft iron, generally considered was preferable to the "hot-short" iron, the working of it heated being easier. These irons, as has already been said, were produced under the same circumstances, excepting the mixture of phosphatic ores for the very hard iron.

Persuaded, then, that phosphorus here plays an important part, I made some trials on a large scale in the high furnace, by introducing phosphorus into the cast iron. I took for this purpose the ore of Villebois (Ain), an oolitic mineral very phosphatic, which, according to the analysis of M. Berthier (Essai par la voie seche, t. II. p. 231), contains sesquioxide of iron 34·8,

* The protoxide of iron, owing to its small quantity, was not separated from the alumina.

† The coal employed came from the mine Du Bois d'Aveize, concession de Terre Noire. It is classified and described by M. Gruner in his memoir (Annales des Mines, t. II, 5e serie, p. 166).

water 12·6, phosphoric acid 0·2, clay 34·4, carbonate of lime 18·0. Owing to the large proportion of phosphorus, I added this ore in very small quantities, so as not to obtain an iron "cold-short." Experiment determined that the proportion should be 1·5 of the charge of ore.

I had then a bed of fusion equal to 240 kilogrammes (624 lbs.) of cast metal containing $0^{k}\cdot106$ (3-10 of a lb.) of phosphorus, which gives an iron containing 0·00045 per cent. of this element. I obtained by this means irons far superior to those previously obtained, and without any loss of its tenacity in the cold; they did not contain the least trace of the "hot-short" qualities. I will cite an example: A piece of iron $0^{m}\cdot055$ by $0^{m}\cdot015$ ($2\times\frac{1}{2}$ in.), manufactured without admixture of phosphatic ore, when heated, broke at every bend; and a piece of the same size manufactured from the cast metal, containing 0·00045 per cent. of phosphorus, resisted fracture perfectly.

The explanation of this remarkable fact, already recognized in practical metallurgy, is thence apparent; the iron and the castings are much better as the qualities and varieties of ores mixed in the bed of fusion are more numerous, and the amelioration of quality is owing to the influence of foreign bodies, such as manganese and phosphorus, from the different ores.*

We cannot disregard, in this case, the influence of phosphorus, which was the only agent introduced into the new portion. The constitution of the slag was the same, and the cast metal had been produced under the same circumstances; the puddling and the reheating were made in the same manner and with the same fuel.

But how is it that the phosphorus can counteract the influence of the sulphur? This question I shall endeavor to answer, by deduction from the facts and experiments made by me during the last two years, persuaded that it is of interest for science, since it throws light on the triple combinations of carbon, iron and phosphorus, besides being of great use in practice.

To arrive at a knowledge of this action of phosphorus upon sulphur in the cast metal, I made two experiments as follows: I remelted in a naked crucible in a forge: 1st, $3\frac{1}{4}$ gram. of an excellent gray white iron, containing much graphite with 0.14 pyrites (bisulphuret of iron.) 2d. $\frac{1}{2}$ gram. of the same iron, with 0.14 pyrites, 0.14 calcined bones, and 0.09 of a refractory white clay.

In these two trials I introduced into the cast iron a fixed quantity of sulphur; but in the last I added also a certain quantity of phosphorus, for the predisposing affinity of the silica for the bases at a high temperature would necessarily lead to the decomposition of the phosphate of lime of the calcined bones, and the phosphoric acid reduced by the carbon of the cast iron would combine with the iron to form a phosphuret of iron. The experiment succeeded perfectly. The fusion was complete, and the temperature was pushed even to the softening of the crucible. The two buttons, when broken, were entirely white, as I have mentioned in a previous memoir, "*Sur l'Influence de soufre sur la nature des fontes.*"

The button which contained only the sulphur bent quite well under the hammer, although the cast iron was of very bad quality: it was only a mass of filamentary crystallizations of protosulphid of iron. This cast iron had a dull aspect, and it was very difficult to pulverize in a mortar; it flattened so as to afford small plates. Certain portions especially were very ductile. These portions, doubtless, contained some of the iron free; for it is known, according to the researches of M. Fournet, "*Sur les sulphures metalliques,*" contrary to the assertions of Karsten (Manuel de Metallurgie, p. 122), that the protosulphid of iron can be partially decomposed in presence of carbon at a high

* Note by W. J. T.—According to Schafhaut (J. fur Chem. xi. 304), cast iron, bar iron, and steel, almost always contain more or less arsenic and phosphorus. Thus the celebrated Dannemora iron and the English Low-Moor iron owe their good qualities to the presence of arsenic; and a particular kind of Russian iron (marked CC ND) from Demidoff's works, at Nischnitagilsk, is indebted for its peculiar properties to the phosphorus which it contains. (Gmelin (Cavendish edit.), vol. v., p. 214.)

temperature. This learned geologist in heating to 150° (pyrometer) in a brasqued crucible some pyrites, obtained a button of protosulphid of iron, which was scarcely at all magnetic. This same button heated strongly a second time under the same circumstances, became after this second fusion strongly magnetic, from which fact it is concluded that a loss of sulphur had resulted, and a production of free iron in the protosulphid.

The button which contained some sulphur and phosphorus was, unlike the first, very brittle; it is easily pulverized, and does not yield in the least under the hammer.

From this frequently exemplified fact in practice, the conclusion has been deduced; that phosphorus injures to a great degree the tenacity of cast iron. In the second button there could be distinguished, by means of a lens, parts of sulphurous crystallizations, and some crystalline particles showing brilliant facets.

The buttons from the two assays were pulverized and analyzed.

* * * The following are the result of two analyses.

The experiment made with pyrites alone gave with 1.77 gram.

Sulphur not attacked by acids	0.0150 gram.	
Sulphate of baryta, 0.33, sulphur	.0455 "	
	0.0605	1.714 p. c.

The fusion made with pyrites and burnt bones, gave with 1.77 gram.

Sulphur not attacked by acids	0.0200 gram.	
Sulphate of baryta, 0.23, sulphur	0.0320 "	
	.0520	1.486 p. c.
Loss of Sulphur		0.228 "

Another gray iron fused with pyrites alone, and again with pyrites and burnt bones, gave by analysis of two grammes the following results:

Fusion with pyrites alone. Sulphur	0.0248 gram.	
Pyrites, and burnt bones	0.0221 "	
	0.0027	0.135 p. c.

On comparing the results of the analyses, there is found in the one case a loss of sulphur equal to 0.228 p. c. of the weight of the iron, and in the other 0.135 p. c. in remelting with pyrites in the presence of phosphorus, since the two fusions of each iron were made in equal quantity of pyrites, and the loss of sulphur was greatest where the calcined bones were added * I think, therefore, that this loss of sulphur was owing to the combination of a portion of this last, with the phosphorus introduced after fusion, these two bodies, in consequence of their great affinity, combining in all proportions to form some very volatile compounds.

To establish undeniably whether this probable combination had taken place, I made some reverse synthetic experiments; that is to say I remelted:

1st. 5 grammes of a gray iron with 0.20 of pyrites, 0.20 of calcined bones, and 0.10 of clay.

2d. 5 grammes of the same iron with 0.10 clay and 0.20 calcined bones, to see what became of the phosphorus after the second fusion in the presence of pyrites.

The two experiments gave me two buttons perfectly melted, but entirely different in their external characters. The first, without being ductile, flattened slightly under the hammer before breaking; its fracture was not smooth and shining, as that of the button resulting from the fusion with the burnt bones without pyrites.

This last, on the contrary, was very friable, did not flatten under the hammer, broke at the first blow; it presented a perfectly smooth surface, was

* The sulphur in the first cast iron was not determined before fusion. It was but of little importance to know this quantity which was in proportion to the others in the two experiments of each iron. It was sufficient to know that it lost more by the addition of phosphorus.

silver-gray, quite brilliant, without any fissure. Apart from its want of ductility, it had many of the exterior characters of nickel.

So great a difference in the exterior characters of the two buttons was sufficient to make me believe in a loss of phosphorus through the presence of sulphur.

As a final test, I remelted again:

5 grammes of a gray cast iron with 0.20 of pyrites, 0.20 of calcined bones, and 0.20 of clay.

5 grammes of the same iron with 0.20 of calcined bones, and 0.20 of clay.

Two grammes of each button from the fusion were analyzed.

* * * * * *

Result of experiments with calcined bones gave phosphoric acid	0.024
Result of experiments with calcined bones and pyrites, phosphoric acid	0.027

It is seen from the two results of the analyses, that the phosphorus did not disappear in the fusion of the iron in the presence of phosphate of lime and pyrites, whilst the analyses in the inverse experiments showed a loss of sulphur, which evidently could not have proceeded from a volatile combination of sulphur and of phosphorus as was first supposed.

M. Gruner, Engineer in chief of the mines, my excellent professor to whom I am indebted for numerous useful counsels in this memoir, advised me to take again the first two buttons and examine the carbon, to assure myself if it did not play an important part in the disappearance of the sulphur.

He had in fact remarked, in an assay by the dry way of ores highly phosphatic, that some isolated granules of the fused metal which had no magnetic properties, rose to the surface owing to their feeble density, and which were, doubtless, phosphuret of iron without carbon; for had they been other than this, they would have been simply a phosphatic cast iron, which would have possessed the magnetic properties of the fused button.

Indeed, it appears from the experiments which I have made, that phosphorus, tending to combine with the iron of the casting to form a phosphuret, replaces a certain portion of the carbon, which in its turn meets with sulphur from the pyrites, and forms a sulphid of carbon independent of that which forms from the presence of pyrites alone without the concurrence of phosphorus.

In this manner we may explain the loss of sulphur, which has been proved to occur without a loss of phosphorus.

These analyses of carbon presenting great difficulties, particularly in the workshop of a metallurgist, I adopted the method of M. Regnault for the combustion of the cast iron, as it seemed the only convenient method of separting these small quantities of carbon.

In open crucibles by a forge fire were remelted:

1st. 10 grammes of very fine iron wire (No 8 of commerce), cut into three small pieces, with 0·20 grammes of pyrites.

2d. 10 grammes of the same wire with 0·20 gr. pyrites, and 0·20 gram. of calcined bones.

The amount of sulphur in the two fused buttons were estimated, in order to ascertain whether there had been a loss of sulphur, as in the fusion of the cast iron, made under the same circumstances.

For if in these two trials the analyses gave the same amount of sulphur, it would be demonstrated that carbon was the sole agent which caused a loss of sulphur in the case of the fusion of the cast iron, and that the phosphorus by replacement of the carbon had assisted in this loss of sulphur. In melting the iron wire in the presence of pyrites and in an open crucible, it might be supposed that a loss of sulphur would occur by oxidation from the air, but such was not to be feared in this case, as a great quantity of iron covered the pyrites completely, preventing all contact with the air.

The two assays succeeded perfectly: the two buttons were well fused. That made with the phosphate of lime was very hard, breaking readily, from

which it is seen that phosphorus tends to make iron very "cold-short." 1·90 grammes of each button of fusion were treated with boiling nitric and a little hydrochloric acid, so as to dissolve every thing completely, except some little granules of sulphur, which were readily collected.

The following are the results of the two assays:

1. Trial with pyrites and calcined bones.

Sulphur not attacked by acids	0·0150
Sulphate of baryta, 0·03: Sulphur,	0·0041
	0·0191

2. Trial made with pyrites alone;

Sulphur not attacked by acids,	0·0001
Sulphate of baryta, 0·065: Sulphur,	0·0089
	·0190

0·0191
0·0190
·0001

From this it is seen that there is no material difference in the quantity of sulphur, since on calculating the sulphur in the sulphate of baryta to five decimals, there is only a difference of a tenth of a milligram. It may therefore be concluded that phosphorus removes no portion of the sulphur when iron is remelted in the presence of pyrites and phosphorus.

On the contrary, when cast iron is melted with pyrites and phosphate of lime, there is always found a loss of sulphur.

The only difference in the results is in the carbon; and it follows, as before stated, that the loss of sulphur is to be attributed to its combination with carbon; a combination facilitated by the presence of phosphorus, which tending constantly to form a phosphuret of iron, replaces a certain quantity of carbon.

We thence naturally infer that irons are less "hot-short" which are obtained with a mixture of phosphatic ores, because of the *influence of phosphorus in neutralizing partially the action of sulphur in the irons.*

These explanations give us also an explanation of a known fact in practical metallurgy, the explanation at present given being insufficient, although partially true. There is no practical metallurgist who, in treating very phosphatic ores, has not obtained, contrary to his expectation, with a proper heat and slags, indicating a complete reduction,—some cast iron completely white.

It has always been supposed that phosphorus gave too great fusibility to the mass, and accordingly prevented the formation of a gray iron. But to this explanation, which has some truth, there must be added the loss of carbon caused by the tendency of phosphorus to form a phosphuret of iron. For if the fusibility were the only cause, the slags should be slightly charged with iron, which is not the case. In all the synthetical trials and analytical results obtained, we find that phosphorus serves to remove a portion of the sulphur, probably by favoring the separation of the carbon of the cast iron, which then combines with the sulphur to form a sulphid of carbon.

Moreover, phosphatic irons, according to Karsten (Manuel de metallurgie), preserve better their heat, pass more quickly to a white heat, a heat which spreads uniformly through the whole; whilst sulphurous irons, and as a consequence those "hot-short," cool rapidly, and very unequally. The bar of forged iron in this condition presents no homogeneity, and breaks very easily. Hence in certain cases the influence of phosphorus, which is generally considered very injurious, may perhaps be advantageous. The metallurgist should use it with moderation, avoiding too great a quantity in the bed of fusion, as it is known that after cooling completely, phosphatic irons are brittle.

It is therefore necessary before using it, to ascertain the required amount

by a series of experiments on a large scale. These experiments should be made with much care, for, according to Karsten, it is known that the extreme limit of phosphorus in a good iron is 0·30 per cent.; if this quantity is exceeded the irons lose their tenacity when cold, and will not resist a shock or blow.

Very phosphatic and "cold-short" irons have ordinarily a grained fracture, with brilliant facets, without any fibres like many strong irons. The practical metallurgist ordinarily selects them for uses where the very soft, slightly "hot-short" irons would be disadvantageous, as in the manufacture of nails. There is often also a demand for certain purposes for brittle iron.

It has indeed been remarked, but without explaining the fact, that certain coarse-grained "cold-short" irons forge very easily. We must not conclude from this (which has often been done), that all "cold-short" coarse-grained irons are always good when hot. In fact, a bad iron may be charged with silicium for instance, which will make it "hot-short" as well as "cold-short," and which will not work nearly as well as a fibrous iron well prepared and free from silicium. It is then necessary to ascertain first that the irons are cold-short from the presence of a small quantity of phosphorus, and not from the presence of another ingredient, or some cause inherent in the metallurgical treatment.

In all the experiments on a grand scale, made to favor the passage of the phosphorus into cast iron without compromising its quality by introducing silicium, I have always observed that the result from a charge containing equal quantities of clay and carbonate of lime was the best. In this case the slags have the following composition :

		Oxygen.	
Silica	48·07 pr. ct.	24·97	24·97
Alumina	15·94	7·44	
Lime	35·99	10·11	17·55

These slags are well suited to a good result; for without being too silicious, they are not injurious to the quality of the iron, in falicitating the reduction of the silica; neither do they contain too great a quantity of base to prevent the decomposition of the phosphates in the bed of fusion, and the passage of the phosphorus into the cast iron.

In conclusion, I will allude here to the memoir of M. Stengel (Ann. des Mines, t. x. 3d serie), who pretends to have assayed very sulphurous irons which were not in the least degree "hot-short." He contends that it is to copper that this property of iron must be attributed. Every one knows in fact that a feeble quantity of copper prevents iron from welding, and renders it "hot-short" in a high degree. But I will say in opposition to M Stengel, that this quality cannot ordinarily be attributed to copper, copper being very rarely present, but as a general thing, to the presence of sulphur. Besides, in all the trials on a large scale which I have made with care, if copper had been the cause of the "hot-short" iron which was obtained, there would have been "fers de couleur" at the time of tretment with charcoal, as well as when the mineral coal was used, which was by no means the case.

When the irons obtained in la Bourgogne and la Franche-Comte by the use of charcoal, and those derived from the same ores treated with mineral coal in the furnace of la Loire, or the Rhone, are compared, vast difference is found, the latter being "hot-short," owing to the pyrites in the coal.

Recapitulation.—From the researches, experiments, and analyses in this memoir, it will be seen :

1st. That traces of sulphur are sufficient to give a bad quality to iron and render it "hot-short."

2d. That the passage of sulphur into the iron takes place generally in the fusion of the ore in contact with mineral coal in a high furnace, and consequently it is in this operation that it must be counteracted.

3d. That phosphorus in the "bed of fusion" removes a portion of the

sulphur in the cast irons by replacing a portion of the carbon, and facilitating accordingly the formation of a sulphid of carbon.

4th. That the quantity of phosphorus is not diminished when cast iron and ns are melted in the presence of pyrites.

5th. That phosphorus in irons facilitates their being worked hot, rendering m harder and more difficult to cut.

6th. That it is necessary to study well the elements in the bed of fusion, so as not to introduce into the irons too great a quantity of phosphorus, so as to render them too brittle when cold by its excess.

JOURNAL OF GOLD MINING OPERATIONS.

EARLY KNOWLEDGE OF GOLD IN CALIFORNIA.

It has become pretty well established, that the existence of rich deposits of gold in Calfornia was known to the Jesuits, soon after their missionary labors commenced on this coast. They, however, carefully guarded and concealed the fact of such treasures being within their reach, and patiently abided an opportunity for its development. Whatever evidences are afforded from time to time, in regard to the progressive recognition of the mineral resources of this part of the continent, possess peculiar interest. Mr. Young Anderson, a Scotch gentleman, who has resided in Central America for more than twenty years, was recently commissioned by the Government of Costa Rica to proceed to New York in connection with Mr. Webster, to negotiate a cession of the transit rights between San del Norte and the Pacific. Returning from his unsuccessful mission, Mr. Anderson stated to a fellow-passenger, on the steamship George Law, that in the year 1837, a priest came to Guatemala, and while on a visit at the house of Don Carlos Meany, proposed an expedition to obtain gold in California. The plan presented was, that Mr. Anderson, who was connected in several enterprises with British capitalists, should use his influence in furnishing funds to fit out a party of twenty colonists to proceed to San Francisco Bay, and explore a river in that vicinity, on the shores of which gold had been found in the sands and crevices of rocks. The arrangement suggested was that the priest, his friend in California, Don Carlos Meany, and Mr. Anderson, should be partners in the undertaking. Numerous pieces of gold, large and small, were exhibited, and it was stated that the natives under the control of the missions could not defend themselves from the Indians of the mountains, having no sufficient arms, or knowledge of their use. Mr. Anderson shortly after went to England, and submitted the proposition to his friends there, furnishing full notes of the interview with the priest, who was known to Don Carlos, together with the strong recommendation of the latter in favor of the scheme. The project found little favor, however; the capitalists were too distrustful to enter upon the venture, and Mr. Anderson had to submit to severe rebukes for his credulousness. There is no question of the correctness of the information furnished by Mr. Anderson; and had not the opportunity thus presented for the promulgation of the great truth in relation to the gold of California been then defeated, its realization, which was so stoutly opposed and denied by the London Times only eight or nine years ago, would have been anticipated by nearly twenty years, and England, perhaps, might have controlled the destinies of both the two great auriferous regions of the earth, California and Australia.—*State Journal.*

GOLD DISCOVERED IN THE MEXICAN CORDILLERAS.

A late arrival from Mazatlan confirms the report that rich gold placers have been discovered in the mountains immediately east of Mazatlan. These

montains, says the Sacramento *Bee*, are of the Great Chain or "Back Bone" that extends along this entire continent from north to south. They connect the Andes with the Rocky Mountains. The foot hills east of Mazatlán are in form very much like the foot hills of our own Sierras, and are distant from the coast some twenty or thirty miles. In breadth they are more than twice as extensive as the gold mountains of California, and if they prove to be only as rich, half the population of the world might make a fair living on them for centuries to come. Indeed, it is not improbable that there is more or less gold in this entire chain, throughout both North and South America.

MOUNT HOPE MINING COMPANY.

The most important undertaking which has yet been attempted in quartz mining in Grass Valley, and indeed we may say in any part of the State, has just been brought to a successful result.

In December last, the Mount Hope Mining Company (late Rocky Bar), on Massachusetts Hill, having nearly exhausted their ground above their then lowest level, resolved to make the effort to strike their ledge at a depth not heretofore attained in any mine in the State. Accordingly a shaft was commenced for that purpose, and after a tedious and expensive labor, occupying a period of seven months' constant work, night and day, and the expenditure of about $30,000 on the shaft alone, the most sanguine anticipations were fully realized by striking their vein at a perpendicular depth of 241 feet, or 350 feet, following its dip. Two hundred and five feet of this distance was driven through solid rock, first slate, gradually changing into the most unyielding greenstone, and costing, the whole distance, $130 for each perpendicular foot.

The first tub-full sent up from the ledge, gave no less than twenty-five specimens, which showed coarse gold. They have since gone down three feet into, and probably through the vein, which is here divided into three distinct plates or layers of five or six inches thick, with the intervening spaces filled with "pay dirt," which affords prospects indicative of an extraordinary yield. Little doubt is entertained but that the vein at this point is fully as rich as at any which has yet been opened.

The great depth at which the vein is now opened proves its richness to an indefinite extent, and secures for the Company an immense amount of working ground. It also shows that we may look with the utmost confidence for the continued richness of our quartz veins, generally, to any depth which we may choose to follow them. The success of this undertaking will infuse new life into all the quartz miners in this neighborhood, and will not be without its beneficial effects on the business of quartz mining generally, throughout the State.

QUARTZ MINING OPERATIONS IN AMADOR COUNTY, CALIFORNIA.

A correspondent of the *San Francisco Bulletin* gives the following very concise exposition of the quartz operations in Amador county:

During the summer months all placer mining ceases in this neighborhood for want of water, and even with that which is pumped up from the leads by way of drainage, there is hardly enough to supply the boilers of the engines, and the batteries of the quartz machinery. Indeed so great is this scarcity, that the mill-owners catch the water that runs off with the tailings and use it, muddy and black as it is, again and again. Clear, pure water is essential to anything like success in the separation of gold from the quartz, for unless it is so, the operation cannot be closely observed, and a loss of amalgam or fine gold as readily prevented.

In contact with and mixed through the quartz in this locality is a soft, black slate, which being pulverized along with the quartz, soon renders the water as black as ink, and thick and muddy. When this water has to be used

again and again with very little time to settle, it is easily seen how great are the disadvantages under which the miners at Amador labor.

The quartz, which is white and hard, and not at all decomposed, contains a large amount of sulphuret of iron, and much of the gold is found in connection with it, which renders its separation difficult and imperfect. To improve the process, a variety of machinery has been tested, and many experiments have been made at these mills, some of which have been decidedly successful.

The process at present in use at the Spring Hill mill, where these experiments have been carried on most systematically and carefully, is as follows:

The batteries are charged with mercury. The quartz, as fast as it is crushed, falls into shaking tables, also charged with mercury. From thence, the fine quartz falls upon a blanket, arranged as a band, and made to revolve slowly, at the rate of twenty feet in fourteen minutes. Here a small portion of free gold and a large part of the iron sulphurets are caught. The process of further concentration is then as follows:—The blanket washings and the sulphurets from the shaking tables are placed in the bed of a large Chili mill, (the wheels of which weigh about six tons,) and are there ground, along with mercury, for twenty-four hours. From thence they are removed to an iron barrel, in which they are ground for twenty-four hours longer, the barrel being hung upon a horizontal axis and turned continually. Inside of it are a number of cannon balls and a quantity of mercury.

The result is, that in the Chili mill and the barrel, the pulverization of the pyrites is rendered very complete, so that most of the gold which was held mechanically is freed and taken up by the mercury, and that which was coated by sulphur is polished or cleansed, so that the mercury can also attack it and amalgamate with it. When both these grindings have been gone through with, the mass is washed in water and the amalgam separated from it. The residue, which is still heavy enough to settle in the water, is again returned to the Chili mill, and re-ground along with the blanket washings of the next day.

Formerly, as is still the case in the Amador mill, no machinery was used to separate the gold from the quartz, after it had passed the shaking tables, except, perhaps, the common riffle trough, or a Stetson's Amalgamator. In the Spring Hill mill, where this plan was first tried, at present the additional process above described, is only used upon the tailings of the rock that is crushed in one battery. The result, however, has been to make an increased yield of over forty dollars per day, or one dollar and a half per ton, for all the rock crushed; and if the whole of the tailings were treated so, the increase would be at least three dollars per ton additional.

At the Keystone mill the process of separation is very much the same, except that the time allowed for grinding the tailings is not quite so long. At the Spring Hill mill two inclined shafts have been sunk about one hundred and seventy-five feet deep, and the vein is from four to twenty feet in width, averaging, perhaps, about twelve feet. It has been worked since 1851.

At the Keystone mill a shaft has been carried to the depth of two hundred feet, where the vein is fourteen feet in width. It has been worked out, for a width of seventy feet, to the depth of one hundred and sixty feet. It is the intention of one of the proprietors to sink the shaft one hundred feet deeper, to see whether or not the rock improves materially in quality.

The Herbertville mill is a short distance south of Amador city. As it was driven entirely by water, the running season has not exceeded four months in each year. Determined no longer to be at the mercy of the ditch company, the proprietors have lately erected new steam machinery. The returns from the crushings of last winter at this mill were $28,872 worth of gold. The expenses in the mean time amounted to $15,000. The expenses for the rest of the year while the mill was not running, amounted to over $7,000, so that a net profit of $5,961 was left as the result of a whole year's operations, though eight months were necessarily nearly lost. This was accomplished with the

water mill, by running fifteen stamps, wieghing four hundred and fifty pounds each. In those four months, the amount of rock crushed was 1,434 tons, the quantity being known exactly, as the quartz was got out by contract. The yield was therefore $20 13 per ton. The year before, the yield was $15 per ton. The increased yield is attributed to the increase of the depth from which the rock is taken, and to an improvement in the process used in separating the gold, blankets have been introduced to concentrate the sulphurets, and the barrel and cannon balls to grind them and amalgamate the gold thus freed. The shaking tables are here dispensed with. During last winter, while over twenty-eight thousand dollars was obtained from other portions of the apparatus, only about fifty dollars was obtained from a Stetson's Amalgamator, and only four or five dollars from riffle-trough through which the tailings escaped. At the time of my visit, the proprietors were engaged in erecting their new machinery, and in widening and re-timbering their shaft. Timbers here rot so as to be unsafe in four or five years.

At Sutter Creek, three miles further to the south, but still on the same lead, other quartz operations are being carried on, on a large scale.

The Eureka Company have three mills, all driven by water, and respectively having twenty, twelve and ten stamps, averaging about seven hundred pounds each, and in winter time crushing about a ton per day to the stamp. In summer time, they are able to run but five or six hours per day, owing to the scarcity of water, from which all of Amador county suffers so severely. The shaft is somewhat over two hundred feet in depth, and the levels between, are three and four hundred feet in depth.

The Union Company have two mills, one of twelve and the other of sixteen stamps.

The Badger Company have one mill of sixteen stamps.

The average width of the vein in this district is about ten feet, and the yield from ten to twenty-five dollars per ton, the average yield being about thirteen dollars. The Union lead, I was told, paid twenty dollars per ton, and a lot of sixty tons from a small lead in the neighborhood, had paid a little over thirty-two dollars per ton. Near the surface most of the gold is free, and as the shafts are deepened, more sulphurets of iron are encountered and the separation becomes more difficult. Though there is more water in Sutter than in Amador Creek, the mining season does not exceed six or seven months in the year. During the summer season the shafts are deepened and levels run, and the rock carted a half a mile or so, down to the mills, as in winter the roads are bad.

In amalgamating the gold, mercury is put into the batteries with the rock when it is crushed. It then passes into shaking tables, charged with mercury, and placed lengthwise before the batteries, with riffles arranged as in the ordinary cradle, and made to rock from side to side by means of an eccentric.

For the purpose of concentrating the sulphurets, at one of the mills an apparatus, such as is used in England for tin ores, is made use of. This is called a buddle, and consists of a pair of wooden arms revolving over a circle like the bed of an arastra, fifteen or sixteen feet in diameter. All the tailings, with the water by which they are accompanied, are poured into an inverted tin cone fastened to the centre shaft. The apex of a similar cone enters the lower part of the upper cone or funnel, and the tailings in pouring over it, are spread evenly around the central shaft or axle. Below each arm another wooden bar of the same length is hung, so that it may be raised or lowered a few inches, and to this a brush of broom straw is affixed, so that when the arms are made to revolve it sweeps lightly over the surface of the tailings. The result is, that the surface of the tailings in the basin is kept smooth and slightly inclining towards the circumference, and the water in draining off has only force enough to carry off the lighter portions, which are the clear quartz, while the heavier particles of the sulphurets of iron and gold settle down and remain. The outer portions of the circle are washed away with a hose, as

valueless, while those a foot or two nearer to the centre are taken up and passed through the apparatus again. The central portion is found to be highly concentrated, and is removed, and is either shipped to San Francisco or Sacramento, to have the gold separated from it by chemical process at the metallurgical works, or else it is ground in revolving barrels with cannon balls and mercury. From forty tons of tailings, in two or three days, about one ton of concentrated sulphurets are thus obtained, from which by chemical processes from $200 to $400 per ton is obtained.

The Amador City mill has twelve stamps, each weighing about 450 pounds, and driven by steam power.

The Spring Hill mill has twenty-eight stamps, twelve of which weigh 850 pounds each, and sixteen weigh 450 pounds. The sixteen stamps are driven by water power in winter time.

The Keystone Company have two mills adjoining each other. The new steam mill contains twenty stamps, each weighing 600 pounds, and the old mill, which is driven by water in winter, has twelve stamps. As these mills are working rock from adjoining claims, which are upon the same lead, there is not much difference in the yield, which is about fifteen dollars per ton.

MINING OPERATIONS IN CALIFORNIA GENERALLY.

(*From the Grass Valley Telegraph.*)

Never since the first settlement of California by Americans, has there been so much attention turned to the quartz mining interest as at the present time. Never before has there been a period when so many new mills were going into operation, so much capital seeking investment in this branch of mining, or a greater number of persons turning their attention to "prospecting" for quartz.

By reference to the following summary for the past month, it will be seen that the business is not only increasing in places where it has already become established, but that it is also extending itself into new and distant parts of the State, forming new centres and planting new interests, which are ere long to grow up into thriving communities, rivalling, perhaps, many of our present most prosperous quartz mining localities. Such facts cannot fail to awaken the most pleasing anticipations with regard to the future and permanent progress of our State.

Our record of "New Mills" for the month, comprises sixteen in number, every one, as far as we have been able to learn, starting under most favorable auspices.

Butte county is rapidly taking her place among the leading quartz mining counties of the State.

The Table Mountain Quartz Company will soon have their mill in operation. It will be driven by a steam engine of 35 horse power. They will run eight stamps and four arastras.

Messrs. Nuter and White, in the same neighborhood, are also putting up a 25 horse-power engine to drive eight stamps and four arastras. Both of these mills are constructed upon the most approved principles and in the most substantial manner. The engines and castings for both, are from the Vulcan Iron Works of San Francisco.

The '49 and '56 Company have nearly completed a splendid steam mill at Spanish town, at a heavy cost. Their prospects are exceedingly flattering. The Virgin Company at this place, are said to be doing well. Considerable energy is also displayed at Yankee Hill, about two miles from Spanish town, where one or more mills will soon go up.

In Yuba county the Garden Ranch Quartz Company, on New York and Ohio Flat, have started their mill, which is driven by water, running five stamps and three arastras. Their prospects are said to be flattering.

The Gold Bluff Quartz Company, two miles above Downieville, on the North Yuba, have finished prospecting their lead, and the result has been such

as to warrant the erection of a large mill, which will be finished in December next, running eight stamps, and will cost $12,000.

Placer county, where, in 1855, only two mills were in operation, now counts ten.

The Placer Hill Company, located near Gold Hill or Shipley's Ravine, have just put their mill into operation. It is driven by steam and runs eight stamps—cost about $8,000.

The Young America Quartz Company's mill, owned by Henson, Brower & Co., was started about the 20th of last month. They commenced with five stamps, and took out $800 the first week, and about $2,000 the second.

Pocahontas lead, three miles from El Dorado, has been leased by H. M. Fiske, Esq. Mr. Stoddart has recently completed the erection upon it of one of his new Quartz Crushing Machines, a description of which is elsewhere given.

McNulty & Co. of Sacramento, capitalists, are now engaged in the erection of a steam mill near this locality.

Swan & Alexander are engaged in prospecting a new lead (as we understand it) on Texas Hill, about two miles from Placerville. They are using a small steam prospecting machine. The vein is said to be improving as it is opened. The prospects, at present, are favorable for the erection of heavy machinery.

Messrs. Shaw & Co. are taking out large quantities of rock from their claims near Tattletown, in Tuolumne County. They have made arrangements for the erection of a mill for crushing, and also a furnace for smelting the pyrites, which are found in great abundance, and are said to be very rich.

"The "Frank Carr" claim in the same vicinity, which is now being opened, promises extraordinary results. The Company have resolved upon the immediate erection of a mill.

Messrs. Kellott & Peterson have purchased a mill lately erected on El Dorado Creek, Mariposa county, and are now removing it to Old Hornitos, where they will use it as a prospecting mill. There are numerous leads in that locality which it is thought will pay handsome wages. The erection of this mill will afford an opportunity for thoroughly testing them. It will be driven by water, of which there is a sufficient quantity, however, to run only six months in the year.

The Good Hope Company, near the South Fork Bridge, in Calaveras county, have recently put their new mill in operation with very flattering prospects. The rock is paying from $25 to $30 per ton. They are running eight stamps.

Messrs. Johnson & Goodsell have a new steam mill nearly completed, about four miles above West Point, in this county. The mines in that neighborhood are said to be paying remarkably well.

The quartz mill just erected by Dr. Harris at Clinton, Amador county, has commenced operations. The lode from which the rock is taken is owned by several prominent citizens of Sacramento county.

The *Shasta Republican* is informed that Mr. J. D. Smith, one of the enterprising proprietors of the Clear Creek Ditch, is about erecting a mill upon Clear Creek, in the vicinity of Muletown. The *Republican* feels quite confident that the veins in that part of the State are fully equal in richness to those of any other portion, and is sanguine in the hope of early and important developments.

The Ditch Company at Mokelumne Hill have recently erected a small prospecting mill near that place, the use of which they tender at a slight advance over the cost of running the same, to such parties as may wish to use it for the purpose of prospecting the quartz veins of that neighborhood. The idea is a good one, and might be advantageously adopted in many other localities.

JOURNAL OF COPPER MINING OPERATIONS.

REPORT OF THE NATIONAL MINING COMPANY.

The first regular Report to Stockholders, by the Directors of the National Mining Company, was published on the 1st day of October, 1856.

That Report included a period of three years and three months, from the commencement of the Company's operations, but did not bring the fiscal condition of our affairs to a later date than the 1st of July, 1856.

It is proposed in the present communication to give as full an exhibit as may be practicable, of the progress of the business of the Company to the 1st of August, 1857—confining the *exact* product of the mine, however, as before, to the year commencing with the close of navigation in 1855, and ending with the same period in 1856.

A statement of the whole quantity of mineral raised and shipped, to the date of this report, will be furnished; but as the accounts for smelting, freight, insurance, &c., are but partially adjusted, it is impossible at this time to give any other than an approximate result, of the reduction and sale of this portion of our copper receipts. By the tabular statement from the books of the Treasurer, it will be seen that there was received from sales of copper, for the year ending with the close of navigation in 1856, $39,156 86, and from assessments collected in full, $165.

The shipments amounted to 223,688 lbs. composed of 191 masses, weighing 110,498 lbs., and 158 bbls. barrel work, weighing 113,195 lbs. and producing when smelted 176,488 1-2 lbs. of refined copper, being very nearly 79 per cent.

In order to show the comparative receipts of the Company, from assessments collected, and copper sold, we reproduce the statement in former Report, in continuation,

FROM THE COMMENCEMENT OF OPERATIONS.

	Assessments.	Sales of Copper.	Total,
To June 23, 1854	$39,656 00	$13,618 39	$53,276 39
From June 23, 1854, to July 2, 1855	49,563 00	24,246 91	73,809 91
" July 2, 1855, to " 1, 1856	20,639 00	11,625 85	32,264 85
" " 1, 1856, to Aug. 1, 1857	165 00	39,156 86	39,321 85
	$110,147 00	$88,648 01	$198,673 01

From the very respectable *subsequent* shipments of mineral for the first nine months of the present fiscal year, say to the 1st of August, 1857, amountting to about 135 tons, we may reasonably calculate upon receiving about 200 tons, as the product of the mine for 12 months, terminating 1st of Nov,. 1857. Estimating this mineral, according to the yield of last year, at 79 per cent. of refined copper, and the product of this estimate as being worth $400 per ton, net cash on delivery, after deducting all charges incident to the transportation, conversion, and sale of the copper, it will give as the net avails to the 1st of November, the sum of $63,200.

Taking the Balance Sheet from the books of the Treasurer, as furnishing rather more accurate and reliable data, we find that the whole expenditure of the National Mining Company, for thirteen months, from the 1st of July, 1856, to 1st August, 1857, amounts to $54,894,09.

The production of the mine during the same period was 356,761 lbs. mass and barrel copper, which at 79 per cent. would be 281,709 lbs, of ingot, or cake copper, worth, at twenty cents. per lb. net cash, $56,358 00.

The comparative statement in Capt. Chynoweth's report refers to an earlier period, and includes several very unproductive months, in 1855, against the same months in 1856, when the mine was producing a good average

It therefore appears that the mine has rather more than sustained itself during the past year, besides defraying the cost—$,2,100, of another quarter section of land which it was thought expedient to purchase, because of its adjoining our

property on the west, and being directly on the course of the National or Conglomerate vein. This tract described as the south-east quarter of section 17, Township 50, north of Range 39, west, containing 160 acres, is finely timbered, and is worth on that account alone, considering its contiguity to our mine, all it has cost us. But its value as a mineral tract is still more considerable, and it may hereafter prove of immense importance from the fact that it is beyond all question traversed b ythe great Conglomerate lode, and other veins, belonging to the National and Minnesota range of bluffs.

our agricultural and mineral land now consists of 1709 65-100 acres, all in one body, well located, and admirably adapted to the business of mining, by reason of the excellent quality of the timber, and the abundant supply of water for washing mineral, use of engines, &c.

The attention of Stockholders is solicited to the fact that our mineral is dressed up to a purity unsurpassed and scarcely equalled by that of any other mine on Lake Superior, thus making an important saving in the items of freight and smelting upon refuse or worthless material.

The last assessment called by the Directors of the Company became due on the first of April, 1856. This assessment was promptly paid, since which the mine has sustained itself, by furnishing copper in sufficient quantity to defray current expenses: and if the ratio of increase, as shown by the comparative results of the last 2 years operations shall continue, we may safely predict, that there will be no further necessity to call upon Stockholders for *material aid*, in prosecuting the work.

Our expenses, however, are likely for the coming year to be largely augmented, by the erection of more powerful machinery, and the employment of a greater force; but it is confidently anticipated, that the production of the mine will keep pace with the additional cost attending the enlargement of our operations, which we trust are destined to result in the most gratifying evidences of increasing prosperity.

A contract has been made for the sale of the entire product of the National Mine, for the current year, upon the following terms, viz: cash, on delivery at Cleveland, as soon as the mineral can be smelted —the price to be regulated by the market price in New York, on the day of delivery, subject to the cost of transportation, and other charges incident to the sales of copper in that city. It is believed that this arrangement is obviously so advantageous, in the present state of our affairs, as to need no further comment on the part of the Board to illustrate its propriety.

Determined to avail ourselves of every reasonable chance of success, in working the mine, the Directors have always had it in view, as soon as proper depth was obtained, to renew their efforts to intercept the North, or Minnesota vein, by another cross-cut in that direction. Accordingly, Capt. Chynoweth has been directed to drive north from No. 5 level, near No. 1 shaft, which is the present bottom of the mine, and corresponds very nearly with some of the points where the two veins are known to have formed a junction in the Minnesota. Making every allowance for a slight divergence in the two veins, on their course west, as well as for the fact, that the conglomerate vein is rather more vertical with us, than upon the neighboring mine east, there is still good reason to believe that we cannot be very far from the North vein.

This work has been commenced, and will be pushed with spirit, although through dead ground at first, in the hope that we shall soon succeed in opening the Minnesota vein, which could easily be worked from our present openings, in precisely the same manner that the Minnesota Co were enabled to avail themselves originally of the riches of the conglomerate vein. There, being still another vein, which shows at the surface, a short distance south of the conglomerate and sandstone, both of which belts of rock are very thin at the National, a cross-cut, south from No. 3 level, near No. 2 shaft, has been commenced, by order of the Board of Directors, with a view to intercept that vein and to ascertain what may be its character in depth.

This is the least expensive mode of satisfying ourselves as to its value, and it cannot, we think, involve the necessity of a cross-cut or drift, exceeding 60 feet in lenght.

These *underground* explorations are deemed very important occasionally, to prevent the possibility of passing by large mineral deposits, which might otherwise be overlooked.

The portable engine referred to in the last Report of Directors, having been worked during the past year, with highly advantageous results, has, after paying for itself handsomely, been found inadequate to the performance of the whole duty of relieving the mine of rubbish, mineral and water, as fast as necessary, notwithstanding the great facilities afforded by the outlet to the surface, from No. 3 Adit level.

It has therefore been determined to supply the deficient parts (lost by a storm, in transitu) of our stampinge-ngine, which has been lying idle for the last 2 years, in a state of good preservation, at the mine. The necessary alterations to convert it into a hoisting and pumping engine, will cost between $3,000 and 4,000; and the additional parts have already gone forward, and the engine is now in course of erection, and expected to be in running order by the 1st of November next.

This engine, which is a vertical beam, with 17 inch cylinder, and 5 feet stroke, is of sufficient capacity to command No. 1 and 2 shafts, for years to come, as well as to operate another shaft, still further east, which it is proposed to construct immediately, by rising and sinking at the same time, from the several levels, as fast as they can be driven to the desired point.

The portable engine is by no means rendered useless by the new plan of operations. It must always be a very valuable agent in sinking new shafts, in sawing, and in a variety of other work about the mine, where steam power can be advantageously applied; and in case of accident to the large engine, it can always be brought into action, as a temporary substitute. Indeed no mine of any considerable importance, should be without one of these very useful and convenient engines.

The attention of the Board has been mainly directed during the past year, to opening the mine *east of No. 2 shaft*, the heaviest deposits of mineral having been found thus far in that direction with but few exceptions. The obvious advantage of this policy is discerned, in the successful effort to make the mine pay its own way, which it could not have done, if extensive operations had been prosecuted upon the unproductive portions of the ground.

The western part of the mine may ultimately be found to contain the richest deposits in depth, and we shall watch closely the developments as shown by the drifts, which we shall be compelled to open in that direction for ventilation, to see if profitable stoping ground can be opened and worked, and levels extended with remunerative results.

It will be expected of course before concluding that some account shall be given of the present position of the law-suit still pending between ourselves and the Minnesota Company, in regard to this property.

It was stated in our last Report, that the case, after being decided in our favor by the Supreme Court of the United States, was again decided by the Circuit Court, at Detroit, in our favor, on all the issues, *old* and *new*. Upon the *new points*, a writ of error was taken by the Minnesota Company, in June, 1856; but for some reason doubtless satisfactory to themselves, they omitted docketing their appeal for trial until the very last moment allowed by law, viz.: on the fifth or sixth day *after* the convening of the Supreme Court, at Washington, in December last.

The effect of this delay was precisely what in all probability was intended, i. e., to preclude the possibility of the cause being tried during that term.

Notwithstanding the ingenious tactics of our *fair-dealing* antagonists, we opine that the final hearing of this cause will take place at the next December term of the Supreme Court, when it will probably be conceded that our opponents have at last exhausted their case.

In this connection the Directors of this Company are reluctantly compelled to notice the following extract from the Annual Report of the Minnesota Company, issued in March last, viz.:

"Considering the undoubted value of this property, and the *extraordinary and unjustifiable means* resorted to, *to wrest the title from the Minnesota Company*, who are, upon *every principle of honor and equity*, *the true owners*, your Directors believe it due alike to the rights and interests of the Stockholders, and the *cause of rectitude and fair dealing*, that no proper means should be omitted, nor exertions spared by us, to bring this controversy to a successful issue."

Our surprise is only equalled by our regret, that language so objectionable and offensive should have been permitted to find its way into the Minnesota Report.

It is not justified either by the merits of the controversy or by the relative character and standing of the parties in the pending litigation.

Our rights in the premises have been fairly and honestly maintained, by no "*extraordinary and unjustifiable means*," but by due process of law, regularly initiated by *mutual consent*, and intended on our part to be honorably conducted to its final consummation.

Ours is not one of those desperate cases, that require to be supported by heavy *contingent* rewards, payable only in the event of success, from the spoils of an unfortunate adversary; nor do we consider it due "*to the cause of rectitude and fair dealing*," to tax the ingenuity of counsel, to interpose any and every legal obstacle, to a prompt and speedy hearing of our cause, for no better reason apparently, than to postpone unavoidable defeat, and as a necessary consequence, the restoration of a "*valuable property*," wrongfully withheld, from the possession of "*the true owners*."

The motion made by counsel, before the Supreme Court, at its last session, "for an order requiring the Minnesota Company to file additional security, in the sum of $25,000 against damages, which we might sustain by reason of their appeal," *was denied* by the Court, for want of power in an *action of ejectment* to require security for an amount greater than the costs of suit, qualified by the opinion, however, that the damages were the proper subject of a *separate action for mesne profits*.

The Board of Directors have the pleasure to affirm their unabated confidence in the ultimate success and prosperity of the National Mine, and to assure the Stockholders, of their well-grounded hopes, of being able to congratulate them in the next Annual Report, upon such an improved state of our affairs, as to satisfy every reasonable expectation, and to dispel all doubt as to the great value of our property.

The brief Report of Mr. William Webb, the superintendent of the mine, furnishes some additional particulars of interest, in regard to the business of the Company upon the surface.

In conclusion the Board of Directors take pleasure in recording their unqualified approbation of the energetic and faithful services of Messrs. Webb and Chynoweth, to whose cordial co-operation with each other, in executing the duties of their respective departments, we are largely indebted for the measure of success thus far obtained.

CHARLES AVERY,
O. G. HUSSEY,
THOS. M. HOWE,
JAMES M. COOPER,
CHAS. RICHMOND.

Pittsburg, Aug. 1, 1857.

The following is the latest from the Lake Superior region, which we cite from the *L. S. Miner:*

The Toltec has taken a mass of considerable size from near the sole of the 3d level at a point not heretofore stoped, which they are preparing for shipment. The ground at this point is very strong, and it is the opinion of the agent, that the continuation of the mass from which this was cut will disclose

other valuable pieces of still greater magnitude. Every indication of improvement now-a-days, and especially with those companies that have persevered in the face of every difficulty, in the full and thorough exploration of their lands, should be hailed with joy by all those whose interests depend on the perfect development of the country for their ultimate value.

At the Rockland mine recent openings on ancient pits have exposed a vein of large size and great regularity, east of their present works, which is destined to be of immense value to the future operations of the mine.

MISCELLANIES.

SEPARATION OF IRON FROM MANGANESE.

Mr. F. Field, writing from Chili, gives a convenient process for the separation of these metals. It consists in boiling the acid resolution with litharge for a few minutes, till all the iron is thrown down and the liquid becomes colorless. The lead must, however, be separated from the manganese; this may be effected by adding a slight excess of sulphate of soda to the liquid before filtration, and a small quantity of sulphuretted hydrogen to the filtrate. His experience fully proves the accuracy of the process.

TREATMENT OF AURIFEROUS SAND.

Mr. Goulding is now carrying on a series of experiments at the works of Messrs. Leigh and Redpath, Limehouse. The new amalgamator that he employs is a cylinder of about 6 feet in length by two feet in diameter. In the inside of this there is a number of revolving fans. A force of water is allowed to pass through the mercury, which is in a chamber attached to the cylinder, which then mixes with the charge. This is agitated; and, after some period, by this process the tailings are found perfectly clean. Mr. Goulding states that by his invention, not only is all the gold saved, but that, likewise, no mercury will be lost—this fact being a great advantage, a not inconsiderable loss having accrued in all the amalgamating processes yet known. So soon as the experiments are terminated we shall give the results.

DRESSING OF ORES.

Mr. G. H. Thost, of Tyndrum, states that where mines in hilly countries are on high ground, and the dressing mill a considerable distance off, it is sometimes a question of economy to bring the ore to the mill in as concentrated a state as possible. Disregarding entirely the picking stuff, the smaller sizes, from a cubic inch downwards, are fit for jiggling. This operation is usually performed by a large wooden lever, on which the sieve is hanging, these being jerked by hand. One of the objections against it is, that the boys and girls move the lever up and down mechanically, without producing the laborious elastic stroke or jerk so necessary. In order to obviate this difficulty he proposes the following simple machinery:—A fly-wheel of such weight and dimensions as in other instances is applied to hand movement; this is acted on by another wheel with three teeth on the arm of the sieve, and jigs in the same manner as that practised by hand. He has practically tried this plan, and finds it easier than any other method; not only is less force required but the jerk is attained. Some care must be taken to observe that the staff is of a sufficient specific gravity, to plunge with velocity into the water, and to produce by the arresting teeth of the wheel and the check that jerk which is so essential.